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Transactions of the American Foundrymen's Association

Comprising the

Report of the Convention at Indianapolis,
June 7th, 8th and 9th, 1904

With the

Reports of the Committees and Officers,
and the Papers presented at
this Meeting

5. N.

Preface

As stated in the Secretary's Report printed later, it was found necessary to economize as much as possible in the printing of the Transactions of the Association, and especially the papers fo: the June meeting. As *The Foundry* generally reprints most of the papers of the Association, the matter was taken up with them and they were asked to state upon what terms they would be willing to print the papers for the Association.

They agreed to set up the type for the papers, to make the cuts and to allow the Association the use of them. They further agreed to have the papers printed and to donate copies of those printed in advance of the Convention for use at Indianapolis, charging the Association only for those furnished the Secretary for distribution to the members.

It is hoped that owing to this very substantial aid furnished by *The Foundry,* the Association will be able to close the next year free from debt, and that in the future the printing can be improved and made muoh better at a less cost per member, which will enable the Association to reduce the dues.

All of the papers for which the manuscript was received in time were printed in pamphlet form before the meeting. There was not time to work out a careful scheme for this printing, and hence each pamphlet was paged from 1 up. The report of the meeting and the papers which have been printed since are paged independently, and the index which is furnished can be made to cover all of the papers by the following scheme.

Place a letter A at the top of the 16-page pamphlet, the first paper in which is "Standard and Systematic Methods for Making Beds." Place a letter B at the top of the paper on "Patternmaking and Its Relation to Foundry Costs." Place a letter C at the top of the paper upon "Payment of Labor." A letter D at the top of the paper entitled "Notes on a Successful Piece Price System" and a letter E upon the paper entitled "The Value of the Chemist and Metallurgist to a Manufacturing Plant."

These papers should then be bound in the order mentioned at the end of the other papers. The index, it will be noticed, contains reference letters applying to articles contained in the pamphlets which were printed before the convention. For instance, if one wishes to find the paper on Standard and Systematic Methods of Making Beds, he will look under S in the index, and there will find the title with the reference A 1, meaning that he must turn to the pamphlet A, and the first page. If one wishes to find the paper on Foundry Apprentices as Seen in One Shop, he will turn to F, where he will find the title, with the reference A 9. It is hoped that this arrangement will enable the members to arrange their transactions for binding without any serious trouble, and in the future care will be taken to see that the papers are so paged that no such trouble will occur.

American Foundrymen's Association at Indianapolis,

June 7th, 8th and 9th, 1904.

The whole of Tuesday morning was given over to registration, sight-seeing, etc., actual work not commencing until the afternoon.

Many of the members and their friends visited the works of the Atlas Engine Co., three trolley cars and a brass band having been arranged for by the local committee to escort the visitors to the works. Every courtesy was extended for a thorough inspection of the plant, the foundrymen being much interested, especially in the use of large molding machines of the company's own manufacture, and in the special melting equipment.

Foundry Foremen's Meeting.

The Associated Foundry Foremen held their second annual meeting Monday evening in the Masonic Hall, with about 75 members present. Owing to the absence of Secretary J. A. Murphy but little routine work was done. The president, C. H. Thomas, of Newark, N. J., suggested the appointment of a committee of five to consider certain proposed amendments to the constitution. This was carried and a committee appointed consisting of the following: President Thomas, chairman; William F. Grunau, Erie, Pa.; David Reid, Columbus, O.; A. W. Link, Erie, Pa.; Thomas Glasscock, Milwaukee, and William Holmes, Indianapolis. The amendments are for the purpose of making more clear the duties of the secretaries of the various local branches of the association, as well as to provide for a system of sick benefits for members.

A feature of the session was a paper by F. C. Everitt, of the J. L. Mott Iron Works, New York City, on "Carbon," which provoked considerable discussion.

First Session.

The eighth annual meeting of the American Foundrymen's Association opened in the assembly hall of the Claypool Hotel, Indianapolis, Ind., Tuesday afternoon, June 7, at 2:30. Addresses of welcome were delivered by the mayor of Indianapolis, Hon. John W. Holtzman, and by the president of the local Commercial Club, John W. Kern, with an invocation by the Rev. Joshua Stansfield. The opening session was given over to the address of President Willis Brown and to the reading of reports from the secretary and treasurer, the committee on the standardizing bureau, committee on foundry trade schools, committee on insuring patterns, committee on instruction papers, secretary of foundry foremen's section, and secretary of metallurgists' section. There was also the presentation of standard specifications for pig iron, and the reading of memorials on "Standard Methods for Measuring the Hardness of Molds" and on "Standard Specifications for Foundry Coke."

Mayor Holtzman in his speech said that it gave him such great pleasure to welcome the association to Indianapolis because its aims were along educational lines; that beyond

ENTRANCE TO ATLAS ENGINE CO.'S PLANT.

merely considering the selfish interests of the foundry industry the association sought to promote the welfare of those who were identified as workers in that calling. He admitted being greatly surprised and considerably chagrined that the city of Indianapolis had no representation in the society's membership and expressed the hope that all the local firms operating foundries would take the proper steps to correct this omission, adding that it was the duty of all who employed labor to assist in the work of uplifting those in their employ, both mentally and socially. "There used to be a time," continued Mr. Holtzman, "when manufacturers took but little interest in those employed, beyond seeing that the work was done, but I am glad to say that the day has come when the employer feels that those who work for him are entitled to consideration beyond the mere question of dollars and cents, and that the man's conduct outside of

GROUP OF AMERICAN FOUNDRYMEN'S ASSOCIATION, TAKEN ON THE STEPS OF THE SOLDIERS' MONUMENT, INDIANAPOLIS, JUNE, 1904.

the factory, in other words, his moral welfare, must be looked after if you hope to get the best results in your shops. And I want to say for the manufacturers of the city of Indianapolis, that they have for some years so conducted their shops that they are eligible to membership in your association in the fullest sense of the word, and I hope they will join you, that there may be full and complete cooperation in this great work which you have undertaken and in which they can so ably assist you."

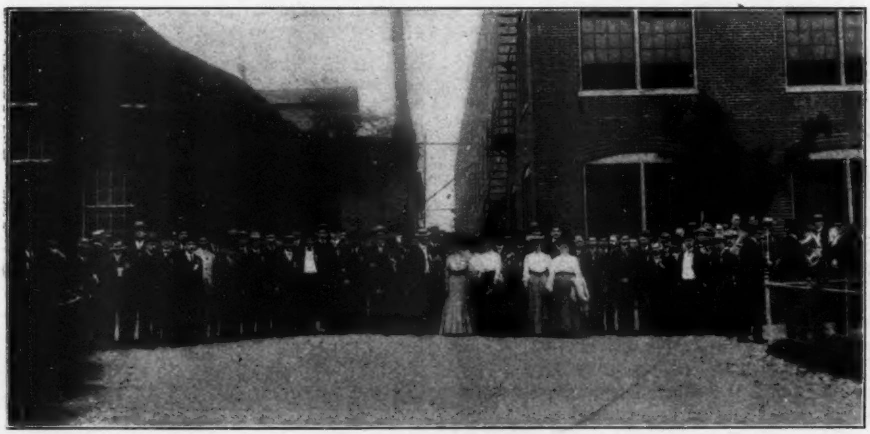
President's Address.

President Brown's address was warmly received. It reviewed the results and changes of the year since the meeting in Milwaukee, not only with regard to association matters, but as to the condition of the foundry industry and the labor situation. He said in part: "These annual conferences are surely worth all they cost, and in the interchange of thought, sentiment, impression and opinion cannot otherwise than be of educational value to all present. Some members content themselves by reading the published proceedings, but that process is sadly wanting in much that goes to make up the value of our meetings. Of more value than the printed words is the privilege of looking into each other's eyes, the friendly grasp of hands and the volumes of thought exchanged which never reaches the pages of the proceedings. The member must be dull, indeed, who goes from our meetings without taking with him new thoughts, new ideas and new inspirations for improvement in methods and policy in shop and office.

"I wish to congratulate our association on the benevolent assimilation of the foundry foremen's section, and to express the belief that the benefits have been quite as great to our association as they have been to the foremen's association. It is to be hoped that this idea of bringing office and shop into closer touch will be carried ahead and favored by a like membership from other branches kindred to our association.

"Along the lines of foundry practice, great progress has been made recently and largely under the auspices of our association. But a few years since pig iron was graded, sold and bought by fracture, and by the physical appearance presented to the keen-eyed, experienced pig iron man. Now a large portion of pig iron is graded by analysis, and a much larger portion is bought and melted by analysis, and no one who has had practical experience along these lines will say that it is not a step in progress. Is it not possible that under the advice of some leaders in thought along the business ends of our affairs, reforms and improvements may be instituted in the buying of materials and selling the product which would be to the advantage of the American foundryman.

"From the number and variety of molding machines which have been perfected and introduced within the past few years, it is evident that the industry is entering a period of rapid progress in this direction, and we believe



GROUP TAKEN AT THE ATLAS ENGINE CO.'S PLANT.

that it will repay every member of this association to give the molding machine his early and earnest attention."

Secretary's Report.

The report of the secretary, Dr. Richard Moldenke, of New York, is as follows:

This has been a year in which labor movements have almost wholly monopolized the attention of the foundry industry. The educational side has naturally suffered correspondingly in the support that should have come to it. As a consequence we have to record a retrogression on the part of our membership and finances, but fortunately not in the standing of the association and its influence in the councils of American Industry.

Perhaps the most important thing accomplished during the past year was the drawing up of a series of specifications for pig iron, cast iron and finished castings. These specifications are before you to-day for discussion. They were prepared under the direction of a committee of the best known men in our industry, nearly all members of our association, and our own and the furnace interests united under the auspices of the American Society for Testing Materials. This marks the first distinct step which gives the benefit of science, already well applied in the foundry, to the commercial side of our work. It will always be counted to our credit as foundrymen that we were the first to work for a good set of specifications, even though we knew that it meant toeing the mark afterward, and to our persistent efforts can this accomplished fact be traced.

We will take up to-day another important matter, which can be made to be of incalculable benefit to the iron and steel trade, and that is the standardizing of coke. We naturally will confine ourselves to foundry coke, but the whole iron industry is looking for some definite commercial basis upon which the good, indifferent and bad cokes can be handled for the best interests of all concerned.

Your officers have been active in various enterprises along educational lines, in the conventions of other associations taking up cast iron as a study, and on committes of national and international character. Your members have assisted in the foundry end of the international dictionary of technical terms now being gotten up in Germany, and today the American Foundrymen's Association is held up as a model educational foundry association to be patterned after in other countries. All this has meant effort on the part of our members, but the results obtained for the industry are well worth striving for. Standardization of method, system in the shop, harmony between the various crafts grouped about the commercial production of castings, and finally the finesse in management which has made our country take the first industrial position of the world—all these combined has been the trend of our ambition, and we are steadily gaining as we learn how to grasp the fruits of American ideas and perseverance and apply them to the foundry.

This work, however, is that of the few in the association, not the many. You will receive the committee reports, and among them that on instruction papers. It is a peculiar commentary on our ideas of progress that not one foundry owner has ordered a supply of those instruction papers for distribution among his men. Our foremen's association, however, has done this for the apprentices under their charge as individuals, and foreign employers have sent for large lots, as they appreciate the value of trained men, and know that some one must do the training.

WAITING FOR THE CARS.

Pursuant to your resolution last year, the *Journal* of the association has been greatly enlarged and a staff of experts added as associate editors. The new *Journal* was widely distributed, not only to gain support for the association but also to give the advertisers their proper equivalent. The result was entirely unsatisfactory, and I can only advise that we leave the field of trade journalism,

which this effort really amounted to, and confine ourselves strictly to the regular transactions, the work of committees, and the usual functions of an association of men looking for results by the interchange of ideas and experiences. While the liabilities thus created must first be liquidated, the cutting off of much of the printing expense will enable the expense to be kept down, and I would recommend an eventual reduction of the dues to a fairly low figure, so that the membership may be increased and the value of the work done enhanced. All the losses we have sustained in the membership are directly due to the heavy expense entailed bv the defense movement. The characteristic reply to my letters asking reconsideration in the case of a resignation invariably is: "We think you are doing splendid work, but the calls for defense are necessitating the cutting off of everything not directly connected with the turning over of the dollar." And yet there is the cry for better and more molders and for efficient foremen and managers.

The present membership of the association is 278. The financial accounts for the year are as follows:

RECEIPTS.		
From dues, sales, advertisements	$2,469 99	
From standardizing bureau	263 32	
Balance for 1903	59 42	
EXPENDITURES.		
Journal		$1,723 15
Printing		160 00
Salaries		400 00
Postage		219 00
Sundries		35 00
Standardizing bureau		229 22
Balance for 1904		25 76
	$2,792 73	$2,792 73

Collections were pretty close, though some $125 is still outstanding. There are, however, unpaid bills amounting to $988.16, distributed as follows: Journal, $206.31; printing, $16.85; salaries, $700; postage, $47; standardizing bureau, $18. This would make a deficit of about $870 for the past year.

While it is necessarily discouraging to see the trend of thought go almost entirely in the direction of defense against labor aggression, yet this will eventually adjust itself on a basis which leaves something to the foundryman to expend in securing himself beyond his immediate necessities. We need therefore only let the force of circumstances act, and simply face the music.

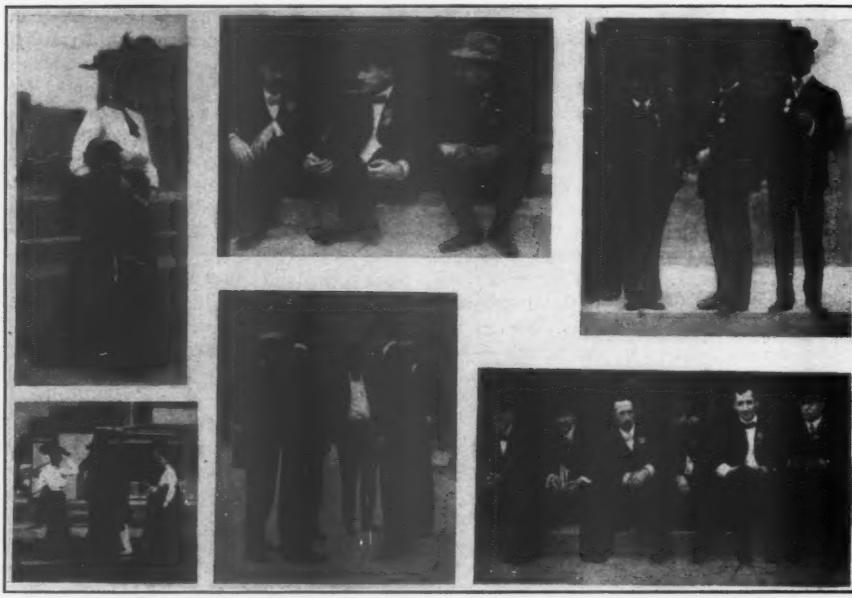
The committee reports and memorials disposed of, the paper prepared by Thomas D. West, on "Standard Systems for Making Green Sand Beds" was taken up. Mr. West read it in synopsis only, showing his hardness tester and calling attention to the tables in the paper. A number of persons took part in the discussion which followed. Later in the day a memorial was presented by John Magee, representing the New England Foundrymen's Association, requesting that the A. F. A. appoint a committee "for the purpose of investigating and classifying the hardness of molds; to establish the proper standards for their measurement, and to list such classes of work as shall seem desirable, showing the most suitable degree of hardness for the body of the mold in each class of work." The president appointed the following members to serve on this committee: Thomas D. West, chairman; E. B. Gilmour, J. A. Murphy, C. H. Thomas, Arch. M. Louden, and David Reid.

The report of the committee on the Standardizing Bureau stated that the demand for samples in the past year had exceeded its ability to supply them. It had about 100 orders in hand for sample "C," which had been in preparation about a year and which was expected to be delivered in the next few weeks. A new sample "D" was being made. The accounts of the bureau to date showed collections amounting to $2,006.16; expenses, $1,054; accounts receivable, $102. Drillings on hand, "A," 37½ pounds; "B," 129 pounds, and "D," 11 pounds.

J. S. Seamans, Pittsburg, made the report of the committee on Foundry Trade Schools. Mr. Seamans told the society of the project under way at Pittsburg, made possible through the liberality of Mr. Carnegie and the Pittsburg municipal authorities for the erection of free technical schools for instruction in all the mechanical arts. He said that a site of 32 acres adjoining Schenley Park had been purchased and that the work for grading for the buildings had begun. The Pittsburg foundrymen had waited on Professor Hammerschlag, the managing head of the institution, and discussed with him the plans for the erection of a large and complete foundry in connection with the schools, as well as the subjects on foundry work for instruction.

Pattern Insurance.

The committee on Insuring Patterns reported that during the year it had held conferences with representative insurance interests, and



1. MRS. ADAMS, OBERMAYER'S LADY REPRESENTATIVE. 2, 3 AND 6. SNAPS TAKEN WHILE WAITING FOR THE GROUP PICTURE TO BE MADE. 4. MR. HILL AND THE LADIES. 5. DR. HOLMES EXPLAINING THE SITUATION.

that it had presented a series of propositions to the National Board of Fire Underwriters for their consideration. These propositions were read before the society.

Instruction Papers.

The committee on Instruction Papers, H. E. Field, chairman, reported that four papers had been written, published and distributed—two on molding and two on foundry metallurgy—and suggested, if the association decided these had proved of sufficient value to warrant their continuance, that a course of papers be started in patternmaking and foundry accounting; also, if the work was to be carried out to its highest efficiency, it would probably be necessary to employ some authorities to write papers, for which an appropriation should be made by the association.

Report of the Secretary of the Metallurgical Section.

In the report of the secretary of the Metallurgical Section, he stated they had been handicapped in enlarging their membership from the outside by the unwillingness of foundry or furnace chemists to pay the $10 membership fee. He suggested that the section should branch out along the lines followed by the foundry foremen and draw its membership from outside the association, which would permit of a reduction in the dues and a large increase in the membership. On the matter of standard methods for analyzing iron, which had been referred to the section, the report stated that "since the last convention, bound copies of the methods of analysis compiled by the secretary had been sent out to prominent chemists all over the country." A personal letter was sent with each one, asking for assistance in this work, and he now had on file a list of many prominent chemists willing to aid in this work.

Standard Specifications for Coke.

In the memorial on "Standard Specifications for Foundry Coke," which was brought verbally before the society by Dr. Moldenke, he said there was a feeling that if it were possible to standardize the composition of a normal coke, so far as the sulphur, ash and the moisture were concerned, or at least the sulphur, arrangements might be made by which coke could be bought and sold on that standard, any excess over it to be compensated for in rebates and any decrease from the standard in premiums. Dr. Moldenke said that the various coke manufacturers had been approached on the subject and that they seemed favorable, especially the by-product men, as the payment

1. MR. WEST IS AN AUTHORITY ON BEDS. 2. OUR NEW PRESIDENT IN THE LEAD. 3. A CROSS CUT FOR THE CAR. 4. WAITING FOR THE GATE TO OPEN.

of premiums for lower sulphur cokes would enable them to buy better coals for coking. The presentation of the memorial caused considerable discussion as to the relative merits of Connellsville, by-product and other cokes, and resulted in the adoption by the association of a resolution to request the American Society for Testing Materials to take up the standardization of coke.

TUESDAY EVENING.

At this session George H. Hull, of New York, read a paper on the "Pig Iron Warrant System as Applicable to the Foundry," which attracted considerable interest, the listeners asking many questions of Mr. Hull regarding details of the system not covered in his paper. The paper of E. H. Mumford, of the Tabor Mfg. Co., Philadelphia, entitled "Molding Machines, their Uses," briefly described the evolution of this class of machinery as well as the various types of machines made. No discussion followed, and the other two papers on the same subject, prepared by Herbert M. Ramp, of Schenectady, N. Y., and S. H. Stupakoff, Pittsburg, were read by title only because of the lack of time to take them up. The paper prepared by H. F. Frohman, Cincinnati, entitled, "Some Labor-Saving Suggestions for the Foundry," as well as those on "By-Product Foundry Coke," by Clarence M. Schwerin, Chicago, and "The Engineer and the Foundry," by Dr. R. Moldenke, were also read by title.

Relative Merits of Eastern and Western Castings.

Following the reading of the paper on "Moisture in Molding Sand," prepared by

W. S. Morehouse, New York City, an amusing and interesting discussion took place as to the relative merits of castings made in Eastern and Western foundries. It grew out of a statement made by David Spence, of the Greenlee Foundry Co., Chicago, formerly of Boston, who said that he had found in his experience that most Eastern foundrymen made better castings than those in the West, which he attributed to the care in the selection of sand used. Quite a number took part in the discussion of this point, though their remarks were more in the nature of banter than serious statements. In the course of his remarks, Mr. Spence gave a formula to prevent scabbing. He said in making a facing of one to six, take five parts new sand and one part of Jersey medium fire sand and mix a facing from that with a proper dampness of the sand, and there would be very little scabbing unless the molder was careless in the finishing of his mold by slicking the Ceylon lead.

The next paper was that of W. H. Carrier, of the Buffalo Forge Co., Buffalo, on "Cupola Fan Practice." After the reading of extracts from this paper, which had not been printed, a heated discussion followed, dealing first with the proportion of the different gases in the products of combustion from the cupola. The consideration of this subject naturally led to the discussion of melting ratios, the general consensus of opinion being that for ordinary machinery castings and light work, 1 to 8 was good practice, though with heavy work and long heats and a large cupola, higher ratios could be obtained. In connection with the discussion on the melting ratio, the question of center blast tuyeres came up, in which the fact was brought out that several foundries in different parts of the country were using or had used successfuly the center blast in large cupolas. The question of the amount of air was finally tersely stated in the following sentence: "The question of blast is not a question of pressure, but a question of volume of air well distributed." By the time this discussion was ended, the midnight hour had passed and the meeting adjourned.

WEDNESDAY MORNING.

Change in Pig Iron Specifications

As a special order of business, the motion of H. E. Field, of Pittsburg, to change the standard specifications for foundry pig iron proposed by the American Society of Testing Materials, which had been presented at the opening session, came up for discussion. The changes which Mr. Field said were necessary, to prevent the report from being considered absurd by those interested in the purchase of iron by analysis, were in the paragraphs referring to "Sampling" and "Allowances and Penalties." On the former the printed report reads: "At least one pig shall be selected at random from each *two* tons of every carload, and so as to fairly represent it." The other paragraph objected to reads: "A deficiency of over 10 percent in the silicon, up to 20 percent, and a further increase in sulphur up to .01 over the above allowance, subjects the shipment to a penalty of 1 percent in the price for each element so affected." Mr. Field stated that no foundry chemist would have the time to take a pig from every two tons, especially where large amounts were used, and suggested that the ratio be changed to read, "one pig from every four tons," which is equivalent to 6 pigs to a car, the method used by a majority of the chemists at the present time.

The change suggested in the paragraph referring to penalties was that, instead of 1 percent, the penalty be increased to 4 percent. Mr. Field called attention to the fact that under a penalty of 1 percent the foundryman would get only about one-fourth of the difference in the cost of No. 2 and No. 3 irons, whereas at 4 percent, he would receive a rebate of about 50 cents a ton, the usual difference in the price of the two grades.

Fred W. Bauer, Cincinnati, took exception to Mr. Field's statements and said that if the market price of iron should take one of its periodic advances to high water mark, the foundrymen would be getting 80 cents a ton, and possibly $1 a ton under the change in penalty suggested; and he doubted if the furnaces would stand for it. He recommended that the simplest and best way would be to establish a definite relative value on different silicon contents, and insert that in the contract in so many words, and moved to amend Mr. Field's motion accordingly.

H. C. Loudenbeck, of the Westinghouse Air Brake Co., Wilmerding, Pa., was another speaker, and wanted the amendment of Mr. Field to contain the clause that if the iron did not analyze within the limits, as set forth by the specifications, the buyer had the right to reject the iron or pay a lower price for it, according as he desired; otherwise, the foundryman would probably be compelled to take a lot of iron which he had no use for.

Mr. Barbier, a chemist, of Milwaukee, said that no hard and fast line could be set down as to accepting or rejecting pig iron, or giving

bonuses or charging penalties on the silicon contents, only as the absence or presence of the three other metalloids governed the quality of the pig iron, as well as the silicon.

After further discussion, which was taken part in by Messrs. Slocum, Magee, Field, Flinterman and others, Mr. Field's motion was presented to the association in its amended form, giving the buyer the right to reject the shipment or accepting it at a penalty of 4 percent reduction in price at his option, and it was carried. It was the sense of the association that before the specifications were finally adopted by the American Society of Testing Materials, the matter should again be referred to the A. F. A.

Foundry Foremen's Section.

With the close of this discussion, the meeting was turned over to the Foundry Foremen's Association, and President Thomas and Secretary Murphy occupied the platform. The president's address was brief, after which the meeting took up the paper prepared by David Spence, of Chicago, on "The Need of Modern Foundries." A number participated in the discussion of this subject, the sentiment of all present being voiced by the statement of one of the speakers that modern men who would not condemn an article before it was tried, were as necessary as modern foundries. Augustus T. Williams, of Philadelphia, said the greatest need of the foundry was the lessening of the demoralizing influence of the drink habit among molders, and told of his experience in his efforts to stamp it out among his own men.

The Apprentice Question.

The paper entitled "The Core Bench," was read by its author, Benj. D. Fuller, Allegheny, Pa., and was followed, without any discussion, by one on "Foundry Apprentices," prepared by Charles H. Thomas, Newark. This was probably the most important paper read at the morning's session, from the standpoint of the interest and discussion it provoked. All those who talked deplored the great lack of suitable material for molder's apprentices and were unanimous in the opinion that something ought to be done to remedy the existing conditions. The blame was distributed by the speakers among the foundry owners, foundry foremen, the boys themselves and on the growing use of machinery. As against the suggestions of Mr. Hay that the foundry foremen take the boys more seriously and undertake to spend a little time with them each day, laying out their work, rewarding good results with more difficult jobs and an occasional raise in pay, preventing the repetition of mistakes by the right kind of instruction, Archibald M. Louden said that from his experience too much pampering of this kind would spoil the apprentice, especially those who were drawn from the illiterate foreign element, which he said furnished most of the foundry apprentices nowadays.

Another speaker said that no general rule could be laid down with regard to the instruction of apprentices. Some were apt, others obtuse, and as you found them so would the foreman have to handle them.

Mr. Gilmour, of Peoria, said he attributed the reason for the lack of good apprentices to the ratio insisted upon by the molder's union, which was altogether too small for the growing needs of the foundry industry.

Mr. Williams, of Philadelphia, said the trouble was largely with the foremen them-

THE PITTSBURG DELEGATION.

selves who kept the boys on cheap work. He had no apprentices in his shop, and added that his conscience would not permit him to encourage boys to follow a calling that was so rapidly being killed by the use of molding machinery and other labor-saving appliances. As showing the difficulty which foundry foremen had to contend with these days in getting good men, he said he advertised some time ago for seven molders to do a certain class of work, and out of 127 men who answered the ad. not one of them was competent to do the work required.

Secretary Murphy advocated night classes for the winter months. He said this had been tried in a district where he formerly lived, with remarkably good results. The various local foundry foremen acted as instructors, the

expenses of maintaining the classes being borne by the foundry owners.

Another speaker said that boys should be taken on six months' trial, and if at the end of that period they did not show enough progress or desire to learn the trade they should be let go. He added that there should be inserted in the indenture papers the right of the apprentice to appeal to the foreman for better work after he had fully mastered the details of that on which he had been put, and if he did not get it from the foreman, he should have the right to appeal to the firm. No boy, he said, should have to feel that he depended on the good will and amiability of the foreman to properly learn his trade.

After this discussion closed, David Reid, Columbus, O., followed with his paper on "Specifications—What They Mean to the Foundryman," after the reading of which the meeting adjourned. The other papers scheduled for this session were read by title only.

WEDNESDAY AFTERNOON.

It had been arranged to devote the afternoon session to a discussion of subjects of interest to patternmakers, while the local reception committee entertained the ladies with a trolley ride around the city. This plan was upset, however, by the appearance of a brass band in the rotunda of the hotel, led by members of the local reception committee, who announced after a few airs had been played, that trolley cars had been provided to accommodate all the convention visitors, and all were invited to take a trolley ride and visit the plants of the Chandler & Taylor Co., American Foundry Co., and the Brown-Ketcham Structural Iron Works. As practically every one attending the convention accepted this invitation, no session was held in the afternoon. At the plant of the Chandler & Taylor Co., the visitors were especially interested in a working exhibit of the Keller rammer made by the Philadelphia Pneumatic Tool Co., in which it was seen ramming up the sub base of an engine frame.

WEDNESDAY EVENING.

The election of officers and the transaction of new and unfinished business, set for Thursday evening, was taken up at a meeting preceding the smoker and concert given by the Indianapolis Commercial Club.

The officers and district vice presidents elected for the coming year are as follows:

President, C. J. Wolff, of the Wolff Mfg. Co., Chicago.

Secretary and treasurer, Dr. R. Moldenke, Watchung, N. J.

Vice Presidents—First District, E. W. Anthony, Smith & Anthony, Boston; Second District, John Mills, Abendroth Bros., Port Chester, N. Y.; Third District, D. J. Thomas, Starrett & Thomas Foundry Co., Pittsburg; Fourth District, A. K. Beckwith, Est. of P. D. Beckwith, Dowagiac, Mich.; Fifth District, H. E. Diller, Western Electric Co., Chicago; Sixth District, T. J. Sheriffs, Sheriffs Mfg. Co., Milwaukee; Seventh District, J. P. Golden, Golden Foundry & Machine Co., Columbus, O.; Eighth District, T. J. Best, Warden, King & Co., Montreal, P. Q.

The auditing committee was reappointed without any change.

With the exception of Messrs. Beckwith, Golden and Best, all the district vice presidents are serving their first term. The retiring president, Mr. Willis Brown, of Erie, Pa., was made an honorary member. The office of assistant secretary, filled last year by H. E. Field, was abolished. The nominating committee which drew up the foregoing list was composed of the following persons: John Magee, Wm. Yagle, H. E. Diller, J. P. Golden and C. H. Thomas.

Following the business session and election of officers in the fore part of the evening the convention was entertained at a smoker and concert given by the local reception committee. Dr. Holmes, chief of the Department of Mines and Metallurgy of the Louisiana Purchase Exposition, made a short speech at the close of the program. He briefly described some of the principal exhibits that he thought would be of interest to all foundrymen, and said he had made the trip from St. Louis purposely to invite the foundrymen to the Exposition and to offer his assistance in making their visit at the Fair both pleasant and valuable. Dr. Holmes told of the plans of the Department of Mines and Metallurgy to make tests of all the coking coals in the country, and asked the co-operation of the association in this work. A committee was afterwards appointed to take up this work in co-operation with Dr. Holmes and his staff. Ex-Mayor Bookwalter, of Indianapolis, also addressed the meeting before it adjourned.

THURSDAY MORNING.

The Foundry Foremen's Section held its business session and election of officers before the regular meeting. The report of the secretary showed that the membership had been

nearly doubled since the last annual meeting, and that the society had a balance of over $50 in the treasury after paying off an indebtedness of $80 existing at the time of the Milwaukee meeting. The following officers were elected to serve for the coming year:

President, C. H. Thomas, Hay Foundry & Iron Works, Newark, N. J.

Vice President, David Reid, Rarig Engineering Co., Columbus, Ind.

Secretary, F. C. Everett, J. L. Mott Iron Works, New York City.

Treasurer, James Murphy, Lane & Bodley, Cincinnati, O.

Vice presidents—Erie District, W. Gruneau, Erie Engine Works, Erie, Pa.; Milwaukee District, T. Glasscock, Pawling & Harnischfeger, Milwaukee, Wis.; Chicago District, David Spence, Greenlee Foundry Co., Chicago; New York District, S. M. Williams, A. & F. Brown, Elizabethport, N. Y.; Indianapolis District, W. H. Holmes, American Foundry Co., Indianapolis.

Before their adjournment the foundry foremen appointed a committe to prepare memorial resolutions as a tribute to Henry Hansen, late editor of *The Foundry* and organizer of their association. A committee of three, consisting of A. M. Louden, James Murphy and F. C. Everett, will have the matter in charge, and the resolutions are to be engrossed and presented to the widow of Mr. Hansen.

The regular session was given over almost entirely to the Metallurgical Section. Probably the most important paper discussed was that of H. E. Field, on the "Effect of Manganese on Cast Iron," which showed the beneficial results of the use of manganese in foundry practice. W. G. Scott's paper on "Scrap Iron" was read by title. R. S. MacPherran read a paper on "Sulphur in Cast Iron." The paper prepared by H. C. Loudenbeck on "The Value of a Chemist and Metallurgist in a Manufacturing Plant" brought out the importance of the chemist to a manufacturing plant, not only in connection with the foundry, but also analyzing the various other materials used. Arch. M. Louden's paper, "Memoranda on the Metallurgy of Cast Iron," was read by title. The paper by H. L. Williams, Chicago, on "Pig Iron and Its Constituent Elements" was read by H. E. Field in the absence of the author. The discussion showed the interest which is being taken by foundrymen and those engaged in the selling of pig iron in subjects of the nature covered in Mr. Williams' paper. R. F. Flinterman, of the International Harvester Co., Chicago, read a paper on "Loss in Malleable Practice." The loss was determined, he said, by carefully weighing the heat as it was made up and by weighing back the products of the melt, the losses averaging about 4½ per cent. This loss was then checked up by the laboratory to account in different ways for this loss and shown how it was divided. It was found that the loss due to chemical change amounted to about 1 percent; the loss due to iron contained in the slag—that is, iron chemically changed and metallic iron too fine to be separated by water mill—amounted to about 2 percent. There was a further loss of about 2 percent due to the sand adhering to pig iron, thus accounting for a loss of about 5 percent, which was slightly in excess of the loss shown by foundry weights. No discussion followed, but foundrymen interested in malleable practice were asked to submit their experience and opinions in writing.

THE BAND THAT STAMPEDED THE CONVENTION.

The paper of H. E. Diller, Chicago, on "Hard Iron," brought out a very interesting discussion in regard to the effects of the different elements on the hardness of iron. The influence of phosphorus in the hardening of iron was especially discussed, and the sentiment of the meeting seemed to be that more information was necessary in order to determine the exact hardening effect of phosphorus on iron.

J. G. Wilson's paper on "The Value of Chemistry in Foundry Practice from a Foreman's Standpoint," was read by the writer and thoroughly discussed. It was an especially interesting paper as showing the growing use of chemistry in making up mixtures for reducing the cost of the product.

In the discussion of standard methods of analysis, it was decided that the most important element to be standardized was sulphur,

and that with this accomplished it would be an easy matter to establish standards for the other elements in iron.

Owing to the limited time left for the association to take up the papers that had not yet been read, the Metallurgical Section adjourned at 11:30 a. m., after inviting further discussion by mail on the papers which had been presented by its members. Four members were added to the committee on standard methods for analyzing iron, making the total number 12. The new members are: H. E. Diller, R. S. Mac Pherran, R. F. Flinterman and H. C. Loudenbeck.

C. J. Wolfe, the new president, now took the chair, and the paper prepared by W. H. Parry, Brooklyn, on "Patternmaking in Its Relation to Foundry Costs," was read by the author, as was also the paper prepared by John Magee, Chelsea, Mass., on "A Successful Piece Price System." No discussion followed.

The Foundry Industry at St. Louis.

The following resolution was then put before the society and adopted:

"That the American Foundrymen's Association commends the action of the World's Fair authorities at St. Louis in arranging for a special foundry building and foundry exhibits; and also for carrying on in connection with these exhibits a series of cooking and other tests of value to the foundry industry.

"That the association urges the foundrymen of the country to aid this important undertaking in every way practical.

"That the association appoints a committee of three to co-operate with the World's Fair Department of Mines and Metallurgy in planning the tests to be made in the exposition foundry and government coke plant."

The president appointed Dr. R. Moldenke, chairman of this committee, and H. E. Field, of Pittsburg, these two gentlemen to select a third member, who will probably be some one interested in the coke industry.

Before adjourning a vote of thanks was tendered by the association to the Commercial Club of Indianapolis, the local foundrymen, the writers of papers and all who had assisted in entertaining the visiting members and their friends.

Next Meeting.

No decision was reached regarding the next convention city. Invitations were received to hold the convention in Cleveland in 1905 and in Philadelphia in 1906. There was a sentiment expressed that it might be well to hold the next convention in a Southern city, and Birmingham was suggested; and there were still others who wanted the next convention held at a summer resort, Atlantic City being mentioned. The matter, however, was left with the executive committee, and the convention then adjourned.

Other Business.

The Metallurgical Section elected R. S. MacPherran, of the Allis-Chalmers Co., Milwaukee, chairman; and H. E. Diller, of the Western Electric Co., secretary.

Before adjournment, the president of the American Foundrymen's Association appointed William H. Parry, of the National Meter Co., Brooklyn, N. Y., chairman of a committee to be selected by himself, with instructions to sound the foremen patternmakers on the subject of forming an organization similar to the foundry foremen and affiliating with the parent association.

In like manner and for the same purpose, John Magee, of the Magee Furnace Co., Boston, was made chairman of the committee, the other members of which are to be selected by himself, to organize the foundry accountants.

Other important work was undertaken by the association for the coming year. Besides co-operating with the American Society of Testing Materials in the preparation of standard specifications for foundry pig iron, it discussed and passed resolutions asking the latter body to take up the question of standardizing foundry coke. The association also appointed a committee to co-operate with the Department of Mines and Metallurgy at the St. Louis Exposition in the tests that are to be made at the Exposition foundry and government coke plant of all the coking coals of the country. It is also working on a system of pattern insurance, co-operating with the National Board of Fire Underwriters in this matter; and has appointed a committee to investigate and classify the hardness of molds and to establish the proper standards of measurements.

Trip to St. Louis.

About 60 members went to St. Louis but no meeting was held there.

On Thursday evening most of the foundrymen took in the Pike. Quite a party stayed at the Inside Inn, though a number of them stayed at other hotels where they had friends or where they had already made arrangements for lodgings. On Friday morning Mr. J. A. Holmes showed the foundrymen through the Mines and Metal-

lurgy exhibit, the gulch and other portions of the exhibition which would be of special interest to them. The frame work of the foundry building was just being erected, but as everything, including a large portion of the exhibits, was on the ground. it was evident that it would not be long before the foundry building, with its exhibits, would be completed. The work on this building had been put back seriously by the continued heavy rains which had made outside work impossible. The portion of the building intended as foundrymen's headquarters was practically complete.

The fair certainly contains a great deal of material of interest to all foundrymen and by the middle of the summer, when all the exhibits are in place, a verv creditable showing will be made. Some of the members remained at St. Louis for several days, taking in the fair at their leisure, while others returned to their homes on Friday and Saturdav.

Those in Attendance.

The following registered during the meeting:

James A. Murphy, Lane & Bodley Co., Cincinnati.

Frank J. Berchtold, Erie Engine Works, Erie, Pa.

John Magee, Magee Furnace Co., Boston, Mass.

S. H. Fisher, Harrisburg Foundry & Machine Works, Harrisburg, Pa.

Wm. F. Grunan, Erie City Iron Works, Erie, Pa.

A. P. Hanrath, Altoona Foundry Co., Altoona, Pa.

Wm. Chambers, C. S. McNeal, Garden City Sand Co., Chicago.

R. E. Turnbull, D. F. Eagan, E. S. Pridmore, Henry E. Pridmore, Chicago.

Henry E. Pridmore, Chicago.

Wm. M. Fitzpatrick, S. Obermayer Co., Pittsburg.

S. T. Johnston, S. Obermayer Co., Chicago.

W. J. Adams, S. Obermayer Co., Milwaukee, Wis.

Justus Thorner, S. Obermayer Co., Cincinnati.

John R. Hayeskie, International Harvester Co., Chicago.

A. M. Ott, International Harvester Co. (Plano Works.)

Philip Wittlinger, International Harvester Co. (Deering Works.)

John O'Donnell, International Harvester Co. (McCormick Works.)

Edward Riley, International Harvester Co. (Milwaukee Works.)

Wm. Yagle, Yagle Foundry & Machine Co., Pittsburg.

W. H. McFadden, N. E. Field, McIntosh, Hemphill & Co., Pittsburg.

D. J. Thomas, Stewart Thomas Foundry Co., Pittsburg.

G. C. Schade, George England, Braddock Machine & Mfg. Co., Pittsburg.

J. S. Seaman, E. Wentz, Seaman, Sleeth Co., Pittsburg.

Harry McEwan, A. Garrison Foundry Co., Pittsburg.

C O. Jones, Rosedale Foundry Co., Pittsburg.

S. D. Sleeth, H. C. Lauderbach, Westinghouse Air Brake Co., Pittsburg.

A. W. Slocum, National Car Wheel Co., Pittsburg.

F. E. Malone, J. S. McCormick, W. M. Wilson, J. S. McCormick Co., Pittsburg.

R. F. Barker, Taylor, Wilson & Co., Pittsburg.

F. M. Zimmers, Union Foundry & Machine Co., Pittsburg.

H. M. Lane, *The Foundry* and *The Patternmaker*, Cleveland.

R. R. Shuman, *Iron Age*, Chicago.

George H. Griffiths, *The Iron Trade Review*, Chicago.

David Spence, Greenlee Foundry Co., Chicago.

David Reid, Columbus, O.

J. Frank Dye, Newport Sand Bank Co., Newport, Ky.

J. T. Reardon, Bullock Electric Co., Cincinnati, O.

Thos. Glasscock, Pawling & Harnischfeger, Milwaukee, Wis.

M. F. Richardson, Kalamazoo, Mich.

Geo. F. Crivel, F. B. Stevens, Detroit, Mich.

BADGES AND SOUVENIRS.

Chris. J. Wolff, L. Wolff Mfg. Co., Chicago.

John P. O'Neil, John Walters, Western Foundry Co., Chicago.

Edward B. Gilmour. Cook Heater Co., Peoria, Ill.

William W. Hutton, Advance Thresher Co., Battle Creek, Mich.

Thos. Robertson, Gould Mfg. Co., Seneca Falls, N. Y.

Wm. H. Gartside, Diamond Clamp & Flask Co., Richmond, Ind.

P. M. Wooden, Reeves & Co., Columbus, Ind.

Milton J. Moore, Illinois Steel Co., Joliet, Ill.

John C. Kneppel, Ames Iron Works, Oswego, N. Y.

Augustus T. Williams, Philadelphia.

E. G. Crawford, Carondelet Foundry Co., St. Louis, Mo.

Thomas D. West, Sharpsville, Pa.

C. J. Wiltshire, Allis-Chalmers Co., Chicago.

E. E. Hanna, Hanna Engineering Works, Chicago.

A. M. Thompson, Link-Belt Machinery Co., Chicago.

E. J. Woodison, Detroit Foundry Supply Co., Detroit, Mich.

Robert Field, C. J. Burton, Field-Evans Iron Co., Cincinnati, O.

David Evans, Field-Evans Iron Co., Chicago.

W. A. Keller, Hetherington & Berrier, Cincinnati.

J. W. Sturgeon, Chandler & Taylor Co., Indianapolis, Ind.

C. H. Thomas, Hay Foundry & Iron Works, Newark, N. J.

H. S. Bell, Dodge Mfg. Co., Mishawaka, Ind.

F. P. Howlett, Dodge Mfg. Co., Mishawaka, Ind.

A. K. Beckwith, P. D. Beckwith Estate, Dowagiac, Mich.

F. C. Everett, J. L. Mott Iron Works, New York City.

E. J. Lyon, Brown & Sharpe Mfg. Co., Providence, R. I.

Walter J. Kohler, J. M. Kohler & Son Co., Sheboygan, Wis.

J. P. Golden, Columbus, Ga.

George J. Hessler, E. A. Hessler, Syracuse Foundry Co., Syracuse, N. Y.

H. L. Williams, Hickman, Williams & Co., Chicago.

Ben. P. Williams, Hickman, Williams & Co., St. Louis, Mo.

R. B. Hickman, Hickman, Williams & Co., Louisville, Ky.

F. M. Eaton, Hickman, Williams & Co., Cincinnati.

Fred. J. Brunner, Cincinnati.

Ed. Fakey, Cleveland.

John D. Ormrod, Emmalls, Pa.

C. E. McArthur, Western Electric Co., Chicago.

George H. Wadsworth, Falls Rivet & Machine Co., Cuyahoga Falls, O.

Thomas S. Bullock, Philadelphia Pneumatic Tool Co., Philadelphia.

Henry S. Potter, Pneumatic Engineering Co., London, Eng.

Hermann Barrett Ridgway, Pa.

T. A. Lovelle, Lovelle Foundry Co., Anderson, Ind.

J. Hill, J. M. Glass, Hill & Griffith Co., Cincinnati.

A. G. Hollingshead, Philadelphia Pneumatic Tool Co., Philadelphia.

Thad. L. Farnham, Whiting Foundry Equipment Co., Harvey, Ill.

Wm. H. Parry, National Meter Co., Brooklyn, N. Y.

Robert Blyth, Walker, Piatt Mfg. Co., Boston, Mass.

J. P. Winlock, Barbour & Stockwell, Cambridge, Mass.

F. H. Chamberlain, P. Smith, Ed. Garland, J. Smith, J. D. Smith Foundry Supply Co., Cleveland.

Willis Brown, Erie, Pa.

Edgar W. Anthony, Edgar W. Anthony, Jr., W. C. Skulley, Smith & Anthony Co., Boston, Mass.

Dr. R. Moldenke, New York City.

Charles Bretzman, Indianapolis, Ind.

Thomas N. Burnman, Shurley Radiator & Foundry Co., Indianapolis, Ind.

U. E. Kanavel, Ayers Mineral Co., Zanesville, O.

F. E. Gordon, Ohio Sand Co., Conneaut, O.

Frank Eiter, Grimes Foundry & Machine Co., Bluftton, Ind.

Fred. W. Bauer, Rogers, Brown & Co., Cincinnati.

F. B. Osborne, Louisville, Ky.

E. M. Drummond, Louisville, Ky.

W. D. Trabue, Phillips & Buttorff Mfg. Co., Nashville, Tenn.

J. J. Burger, Lane Mfg. Co., Montpelier, Vt.

John W. Burr, Burr & Houston Co., Brooklyn, N. Y.

Nat'l H. McPhee, Ansonia, Conn.

T. L. Griffith, T. P. Kelly & Co., New York City.

F. W. Shryer, Bloomfield Mfg. Co., Bloomfield, Ind.

Edward E. Barbier, Milwaukee, Wis.

Arch. M. Loudon, Abendroth Bros., Port Chester, N. Y.

George H. Hull, Sr., and George H. Hull, Jr., American Pig Iron Storage Warrant Co., New York.

John McLaren, Phillips & McLaren, Pittsburg.

W. H. Carrier, Buffalo Forge Co., Buffalo.

John Reynolds, Indianapolis.

Wm. Davis, Indianapolis.

Benj. D. Fuller, Pittsburg.

L. H. Chesley, Danville, Ill.

J. W. Dopp, Tabor Mfg. Co., Chicago.

Jos. F. Rothe, Green Bay, Wis.

Jos. J. Wilson, Leland & Faulconer Mfg. Co., Detroit, Mich.

B. J. Taylor, Toledo, O.

Charles L. Bieler, Indianapolis, Ind.

M. J. Colligan, Hamilton, O.

W. W. Ricker, Hamilton, O.

W. W. Sly, Sly Mfg. Co., Cleveland.

H. E. Diller, Western Electric Co., Chicago.

G. Hokanson, Three Rivers, Mich.

F. S. Pevey, Pevey Bros., Lowell, Mass.

G. A. Williams, Aermotor Co., Chicago.

Mathew C. Perry, Anderson, Ind.

J. C. Merrill, Lock Haven, Pa.

C. M. Gibson, Williamsport, Pa.

J. M. Pickands, Pickands, Mather & Co., Cleveland.

Chester A. Peebles, Mathew Addy & Co., Cincinnati.

R. S. McPherran, Allis-Chalmers Co., Chicago.

Irvin McDowell, Field-Evans Iron Co., Chicago.

W. S. Pattin and T. O. Pattin, Pattin Bros. Co., Marietta, O.

W. E. White and L. Luddy, Muncie Foundry & Machine Co., Muncie, Ind.

E. E. R. Trautman, *Engineering News*, Chicago.

Lyman Arms, Columbus Iron & Steel Co., Columbus, O.

R. F. Flinterman, International Harvester Co., Chicago

E. J. Taylor, Toledo.

Edwin Seedhouse, Falls Rivet Machine Co., Cuyahoga Falls, O.

Dr. Holmes, chief of Department of Mines and Metallurgy Louisiana Purchase Exposition, St. Louis.

THE NEW PRESIDENT OF THE A. F. A.

Chris J. Wolff, the newly elected president of the American Foundrymen's Association, is the second vice president of the L. Wolff Mfg. Co., Chicago, manufacturer of plumbing specialties and supplies, and is superintendent of the company's works at Hoyne and Carroll avenues. He was born in Chicago and is 43 years old. All his working life has been spent with the concern with which he is at present connected. He entered the factory as a boy and worked through its different departments until he fully mastered the business in all its

details. Mr. Wolff is a thorough foundryman, not only having spent a number of years working on the floor, but having also studied chemistry in its relation to foundry practice, and gained a diploma therefor.

Local Committees.

The local entertainment committee was made up from the members of the Commercial Club, being assisted by the officers of the Indianapolis Foundry Foremen's Association. The Commercial Club committee consists of W. M. Taylor, chairman, Hugh R. Richards and

CHRIS. J. WOLFF.
(The New President of the A. F. A.)

Lewis Hoover. The foundry foremen's committee is as follows: William Balmer, Brown-Ketcham Iron Works; W. H. Holmes, American Foundry Co.; William Keller. Hetherington-Berner Co.; John Revnolds. Enterprise Foundry Co.

SCRAP IRON SPECIFICATIONS.

BY W. G. SCOTT, RACINE, WIS.

"Scrap Iron" is the name usually given to the miscellaneous collection of broken and worn out castings used along with pig iron in making foundry mixtures.

Strictly speaking, the term applies more appropriately to the conglomeration of iron known as "foreign scrap" or that which is obtained from the junk dealer, who makes a business of collecting such material.

Home scrap consisting of gates, sprues, risers, defective castings, and "shot iron" is more properly termed "the remelt," and at the present time where most foundry mixtures are made by analysis, its composition is not considered as an "unknown quantity."

The object of this paper is a general classification of the material known as "foreign scrap" which at the present time, in many cases, is purchased by specification.

Under the head of foreign scrap may be included the following kinds of material, viz.: Gray iron, chilled irons, malleable iron, cast borings, steel, wrought iron, and steel or wrought iron borings.

The common gray-iron cupola founder will prefer a good grade of gray iron scrap; the malleable iron founder may wish to include steel scrap; the Mitis metal maker will want wrought iron, and the cast-steel producer may require something else, therefore the necessity of a general classification.

The writer has been requested by several large manufacturing concerns to classify the material in such way that it may be controlled by specification if desired, but as a rule such classification can only be brought about by the purchaser insisting upon the agent or junk dealer sorting the scrap, or in case it is not sorted, to claim a rebate before paying for the material.

It is proposed to classify foreign scrap as follows:

(1) Light machinery scrap (gray-iron).
(2) Heavy machinery scrap (gray-iron).
(3) Stove plate scrap (gray-iron).
(4) Car wheel and chilled iron (gray-iron).
(5) Cast borings.
(6) Malleable iron scrap.
(7) Steel scrap.
(8) Wrought scrap.
(9) Mixed scrap.

It is impossible to establish a cast iron rule, or to formulate a rigid specification in regard to the classification of scrap, as such a course would have a tendency to raise the price of the better grades and force the culled material upon the small foundries.

It is proposed to briefly describe the kind of material suitable for each particular class, explain its proper use, and give a general average analysis of the iron or steel.

(1) Light Machinery Scrap.

This class of scrap will usually consist of the broken parts of agricultural implements, sewing machines, ornamental iron work, cast fixtures, etc.

Most of the material will be less than two inches in thickness, except certain portions like the hub of a wheel, or perhaps a large support; as a rule, however, the iron will be thin and consequently should be soft.

The average analysis of light scrap will generally be found to be within the following limits:

Silicon	2.00	to	2.60	percent
Sulphur	.075	to	.095	percent
Phosphorus	.70	to	.90	percent
Manganese	.20	to	.60	percent
Total Carbon	3.00	to	4.25	percent

Light machinery scrap is considered superior to all other grades for general gray-iron work. It increases the strength of soft iron mixtures and produces but little slag, unless much rust be present, in which case it has a tendency to harden the iron somewhat and increase the "melting loss," the rust uniting with the slag to form silicate of iron which is an undesirable element in good cupola practice.

The proper amount of scrap to be used in melting will, of course, depend upon the quality of castings desired.

The usual amount is from 30 to 50 percent, but with a medium low sulphur and the desired silicon there is no objection to an unlimited increase.

Some foundrymen use all scrap with a little ferro-silicon softener and a small amount of ferro-manganese, but such mixtures are uncertain and cannot be controlled by analysis or otherwise.

Increase in scrap means decrease in total carbon, hence the iron becomes harder, stronger and more close grained.

Light machinery scrap, if sorted, costs almost as much as pig iron, therefore in most cases the buyer makes no distinction between light and heavy machinery scrap, merely specifying that no large pieces shall be included.

The following specifications cover this point:

Specifications for Machinery Scrap.

Under this specification is desired a good, clean scrap iron, such as agricultural implement and light machinery scrap.

The scrap must contain no wrought iron, steel, stove plate, grate bars, car wheels, brake shoes, chilled roll, etc.

Malleable scrap is objectionable, also an excess of rusty iron.

Large pieces weighing more than 400 lbs. will not be accepted.

When a car of scrap is received the inspector will superintend the unloading and discard the following objectionable material, viz.: Wrought iron pieces, steel, burnt stove plate, grate bars, car wheels, brake shoes, large chilled work, burnt malleables, and large pieces weighing more than 400 lbs.

Rejected scrap will be deducted from the total weight of scrap received, and payment made only on accepted material.

(2) Heavy Machinery Scrap.

As the name implies, this scrap will consist of large pieces from fly-wheels, engine beds, large pumps, blowing machinery, mining machinery, gears, cast die blocks, mill castings, architectural castings, etc.

The pieces may weigh several tons or may be broken into small pieces, in any event the pieces will naturally be large and heavy, consequently will be too large for the ordinary cupola.

The breaking of heavy castings is a serious problem and not only involves an extra amount of work, but adds to the expense.

The average analysis will usually be found within the following limits:

Silicon	1.60	to	2.20	percent
Sulphur	.075	to	.150	percent
Phosphorus	.40	to	.80	percent
Manganese	.30	to	.90	percent
Total carbon	2.75	to	4.00	percent

Heavy scrap is generally used for heavy work, and should be melted in a large cupola.

The amount varies from 20. to 60. percent, but should not exceed 50. percent if the iron is mixed by analysis and the castings are to be made by specification.

Where the resultant castings are not made under specification any amount may be used, provided enough silicon be present to insure a fairly soft iron for machining.

Specifications for heavy scrap are worded as follows, viz.:

Specifications for Heavy Cast Scrap.

Material purchased under this specification is understood to belong to the class of cast iron known as "heavy scrap," consisting of bed plates, gears, wheels, supports, engine parts, cast pipe, heavy machinery, etc.

The following material is objectionable and will not be accepted, viz.: Burnt annealing pots, burnt furnace castings, wrought iron or steel shafts, steel plate, sheet iron, galvanized iron, etc.

Such material will be thrown aside and payment made only on the accepted scrap.

(3) Stove Plate Scrap.

New stove plate is considered as an excellent soft scrap on account of the high silicon, graphite and phosphorus content.

Old stove plate containing burnt iron and an unlimited amount of rust, is objectionable, and many foundrymen will not use it at all. Old stoves and furnace castings which have been in use for years are generally pretty well "burnt" and consequently are high in sulphur and low in graphite.

New stove plate is scarce and high in price, while old stove plate is cheap; therefore very little of the former article is found in the scrap now on the market.

No specification calling for *new* stove plate scrap would be effective, as it is almost impossible to get such a grade.

The only specification that we know of makes no such distinction, but deals with the ordinary mixed scrap in the following manner:

Specifications for Stove Plate Scrap.

The scrap purchased under this specification is assumed to be a soft cast iron consisting mostly of *broken* parts of stoves and furnace castings.

An admixture of light machinery scrap is permissible, but parts of stoves from the fire box are objectionable, also pieces which are badly warped or burnt.

On receipt of a shipment or load of stove plate scrap the material will be sorted and the "objectionable" material laid aside.

The purchaser retains the right to reject such material, or to accept it at a reduced price, providing it may be made into grate bars, sash weight, etc.

It is distinctly understood that this latter clause be optional with the purchasing agent.

It will be seen from the above specification that there is a serious objection to burnt iron, yet there is a desire to keep such poor material providing the price is right, and we are inclined to think that all of the burnt iron is not made into sash weight.

Taking the average run of stove plate scrap, including a small amount of fire box parts and other objectionable pieces, the material will generally analyze within the following limits:

Silicon	2.30	to	3.30	percent
Sulphur	.075	to	.135	percent
Phosphorus	.45	to	1.25	percent
Manganese	.20	to	.70	percent
Total Carbon	3.50	to	4.50	percent

There is a wide variation in the above, but it must be remembered that there is a vast difference in the composition of new and old stove plate scrap, furthermore that one founder believes in high phosphorus and silicon, whereas another might think the desired fluidity could be obtained with a high carbon and silicon, both, however, adhere to the high silicon idea.

High phosphoric iron is easily fusible, while high graphite iron is the reverse, consequently the latter mixture is now favored.

The following analysis of new stove plate and the same material after two years' usage illustrates the difference in composition:

	New Material	Old Material.	
Silicon	2.60	2.52	percent
Sulphur	.089	.117	percent
Phosphorus	.720	.731	percent
Manganese	.30	.21	percent
Combined Carbon	.20	.42	percent
Graphitic Carbon.	4.00	3.56	percent

The piece in question was said to be part of the fire box and the claim is made that the great increase in sulphur was due to the absorption of sulphur from the coal, evidently it must have been a poor grade of soft coal.

(4) Car Wheel and Chilled Iron Scrap.

Car wheel scrap is a very desirable material for strong and hard cast iron mixtures.

The only objection to this class of scrap for use in the ordinary foundry is in the size of the pieces and the labor required to break the wheels into sufficiently small pieces.

A 1,000-lb. weight dropping 10 ft. is hardly sufficient to reduce the large wheels to proper size, consequently repeated blows are required and much time consumed.

A larger weight or higher drop is more effective, but very few foundries are supplied with the proper apparatus.

For large work and with a large cupola the trouble is not so great.

"Car wheel scrap" is considered a superior grade of cast iron on account of the low phosphorus content and consequent strength.

The following specification gives a good idea as to the quality of cast iron which may be included in this class:

Specifications for Car Wheel and Hard Iron Scrap.

The following material will be accepted under this specification, viz.: Cast iron car wheels; chilled iron rolls, gears, grinders, etc.; semi-steel castings; cast iron gun metal; steam cylinders etc.

Brake shoes, malleable iron car scrap, journal boxes, etc., are not desired.

Steel castings and die blocks are also objectionable unless especially specified.

All undesirable material will be sorted out, and may be rejected, or retained if found to be in accordance with out specifications for such other class of scrap.

The sorting of material will be superintended by the inspector and payment made in accordance with the class of scrap received.

Specifications for scrap iron are liable to be drawn too rigid, but the desire to obtain a class of scrap suitable for certain specified purposes is an excuse which must not be overlooked.

Car wheel and hard iron scrap although very desirable for certain classes of work, must be used with caution in ordinary foundry mixtures, as the low phosphorus and silicon have a tendency toward sluggish iron or lack of fluidity.

There is quite a variation in the chemical composition of car wheels, chilled rolls, semi-steel, etc., belonging to this class of scrap, but the following limits will be a close approximation:

Silicon	.50	to	1.75	percent
Sulphur	.075	to	.150	percent
Phosphorus	.30	to	.65	percent
Manganese	.30	to	.90	percent
Total Carbon	2.00	to	3.75	percent

If semi-steel were not included in this class the average analysis would correspond closely with that of a good cast iron car wheel mixture.

(5) Cast Iron Borings.

Cast borings can hardly be considered as a legitimate scrap iron, and as a rule are not desired by the foundryman.

On account of the fineness of the particles much of the iron is lost in melting either by being burned up or oxidized, or uniting with the slag.

In some cases the loss exceeds 30 percent, and under the most favorable conditions is seldom less than 10 percent.

Numerous methods have been tried in melting borings, one of which is to inclose them in strong pine boxes and charge in the cupola along with the pig iron.

Another method is to enclose them in sheet iron boxes, but this is somewhat expensive and not very satisfactory.

Borings made into briquettes with pitch are not a success, as the binder melts too easily. Briquetted with lime, salt, cement, etc., this defect is overcome, but other objectionable features are presented, in which the excess of rust, due to the water introduced, is a serious objection.

The amount of metallic iron in a good cement bound briquette seldom exceeds 80 percent, if, however, we include the graphite, manganese, etc., the total considered as pig iron would not exceed 88 percent, thus leaving at least 12 percent of residue which goes into the slag.

The amount of binder or cement is usually about 5 percent, while the remaining 7 percent consists of iron oxide, water, dust, etc.

Briquettes have been made with more iron than above stated, but actual experience has proven that the regular run of such material is similar to the above figures.

Good results are obtained by melting 10 to 20 percent of briquetted boring with regular scrap and pig iron.

Briquettes melted alone produce an excess of slag and bung up a cupola so that it is impossible to draw off the iron.

The ideal method of melting borings is by means of an air furnace or the open-hearth furnace, in which event the iron takes up very little sulphur, although there is quite a loss from oxidation.

Borings melted in a cupola (using the material packed in wooden boxes) is as good a method as any yet devised in general foundry practice, but there is considerable loss or waste and a large increase in the sulphur content.

Borings showing on analysis .085 percent of sulphur, melted with foundry coke (containing .80 percent of sulphur), will produce an iron containing about .120 percent of sulphur.

Borings mixed with tap cinder and ore produces an interior quality of pig iron, and fortunately there is very little of it on the market.

The only specification we know of for this class of material reads as follows:

Specifications for Cast Iron, Steel and Wrought Iron Borings.

In making contracts for borings it is stipulated that the manufacturer, machine shop, or iron mill superintendent, see to it that the different kind of borings, punchings, etc., be stored in proper bins and covered in such manner as to exclude rain and snow.

Separate bins must be provided for cast iron borings; steel borings, punching, etc.; and for wrought iron borings.

In case the borings are mixed a reduction in price previously agreed upon will be made.

Borings freed from oil by means of a centrifugal machine or similar device will be paid for at the price affixed in the contract.

In the above specification the last clause relating to oil seem rather superfluous, as most manufacturers consider the oil more valuable than the borings and endeavor to save it.

The average analysis of the three different kinds of borings may be appoximated quite closely, but the variation is necessarily great.

Variable analysis of cast iron borings:

Silicon	1.50	to	3.00	percent
Sulphur	.075	to	.165	percent
Phosphorus	.30	to	1.25	percent
Manganese	.20	to	.90	percent
Total Carbon	2.50	to	4.50	percent

Variable analysis of steel borings:

Silicon	.00	to	.50	percent
Sulphur	.015	to	.095	percent
Phosphorus	.015	to	.18	percent
Manganese	.10	to	1.00	percent
Combined Carbon	.10	to	1.50	percent

Variable analysis of wrought iron borings:

Silicon	.00	to	.15	percent
Sulphur	.008	to	.045	percent
Phosphorus	.011	to	.35	percent
Manganese	.00	to	.15	percent
Carbon	.00	to	.10	percent

(6) Malleable Iron Scrap.

There is very little call for malleable iron scrao among the gray-iron founders and the malleable iron men are somewhat adverse to using anything except that which they are familiar with, especially in the annealed form.

White iron is not to be had, as the malleable iron founder can use all the sprue he can make, providing it is of good quality, otherwise some of it may occasionally be found on the market.

Saddlery hardware is generally a pretty good class of scrap, but it is so small in size that there is never a great accumulation.

Burnt annealing pots, over-annealed iron, burnt sprue, etc., is an objectionable class of material, but it is frequently used for sash weights, grate bars, etc.

The loss in melting burnt iron, scale, and rust, is, however, so great, and the resultant casting so poor, that it is a question if such work pays.

We know of no printed specification for malleable scrap but nearly every class of scrap from light machinery to car wheel generally contains various amounts of malleable iron castings either large or small, and it is simply impossible to make a fine distinction in the matter.

A reasonable amount of malleable iron in gray iron scrap is seldom objected to.

The malleable iron man claims that there is very little malleable iron on the market, as such material never breaks.

The average limits of a malleable iron analysis will be as follows:

Silicon	.30	to	1.75	percent
Sulphur	.035	to	.095	percent
Phosphorus	.011	to	.22	percent
Manganese	.15	to	.50	percent
Total Carbon	1.85	to	4.25	percent

If the total carbon is low the indications are that steel has been used in the mix or that the material has been long annealed.

Malleable scrap is not liked by the gray iron founder on account of the low phosphorus and low silicon, both of which reduce the fluidity of molten iron.

In gray iron castings it is desirable to use an iron containing not less than .30 percent of phosphorus, and for light castings .70 percent is preferable.

In malleable iron mixtures it must not exceed .22 percent, in fact a low phosphorus is desired.

(7) Steel Scrap.

Steel scrap is coming into use more and more every day and is in great demand

It used to be considered an impossibility to melt steel in the cupola and have it mix with the cast iron, but nowadays it is common pracand many foundries are melting from 10 to 40 percent of steel scrap.

With a little experience in charging, regulating the blast, fuel, etc., perfect mixtures may be obtained.

The object in using steel scrap is to reduce the amount of graphitic carbon (in reality it actually reduces the total carbon to a certain extent), thereby producing a hard, strong, close grained iron.

Steel scrap is seldom used in soft iron mixtures unless there be danger of "kish," in which event 50 lbs. of steel to a ton of iron is sufficient to overcome the difficulty.

With 30 percent of steel, 15 to 20 percent of Home Scrap, and the balance pig iron, estimated so that the resultant castings contain 1.50 to 1.75 percent silicon, sulphur not over .075, manganese about .50 or .60, and phosphorus at .40 to .50 percent, the iron will have a tensile strength of 35,000 to 40,000 lbs. per square inch, and the transverse strength on a one-inch square bar, 12 in. between supports will be between 3,600 and 4,500 lbs.

In charging steel scrap in the cupola it must be borne in mind that no small pieces be used, as such pieces seldom melt, consequently mix with the iron and produce hard spots.

Steel rail cut into 16 to 24-in. lengths are considered the best scrap.

The following specification covers the size and other desired points:

Specifications for Steel Scrap.

Under this specification no distinction will be made between open-hearth or Bessemer steel, the main point considered will be in regard to size and general composition.

It may be optional with the purchasing agent to order steel rail, steel castings, clippings, or mixed steel scrap.

In ordering steel rail it is understood that the pieces are to be cut to a length of not less than 12 in. or longer than 24 in. (16 to 18-in. lengths preferred).

In the event of steel castings being ordered, we reserve the right to reject all small pieces, i. e., less than 6 in. in diameter, and extremely large pieces weighing more than 500 lbs.

When mixed steel scrap is ordered it is distinctly understood that no small pieces will be accepted, the smallest size being limited to 6 in. in length or diameter in flats, sheet punchings, clippings, etc.

No borings or shavings will be accepted.

Mixed steel scrap may include—steel shafting, boiler plate, structural steel, springs, cutlery steel, tool steel, cast steel, rail, machinery steel, etc.

Steel scrap shall be divided into the three following classes, viz.:

(A) Rail steel.
(B) Steel castings.
(C) Mixed steel scrap.

The purchasing agent will order the material according to this code, and the inspector will see that the shipment is sorted according to class. Payment will be made on this basis only.

It will be noticed from the above that the preference is for rail steel.

In regard to the other two grades, i. e., steel castings and mixed steel scrap, there is a difference of opinion as to which is the best, some prefer the cast steel while others like the mixed scrap.

The following analysis gives a good idea as to the composition:

Limit analysis of rail steel:

Silicon	.04	to	.50	percent
Sulphur	.025	to	.125	percent
Phosphorus	.04	to	.14	percent
Manganese	.18	to	1.50	percent
Combined carbon	.20	to	.80	percent

Limit analysis of steel castings:

Silicon	.02	to	.50	percent
Sulphur	.012	to	.065	percent
Phosphorus	.02	to	.12	percent
Manganese	.20	to	.80	percent
Carbon	.15	to	.90	percent

Limit analysis of mixed steel scrap:

Silicon	.00	to	.75	percent
Sulphur	.005	to	.125	percent
Phosphorus	.005	to	.25	percent
Manganese	.10	to	1.50	percent
Carbon	.10	to	1.50	percent

The great variation in mixed scrap may be accounted for from the fact that this class of material will contain a mild steel with .10 percent of carbon or a die block of tool steel with 1.50 percent of carbon.

Tungsten, chromium, molybdenum, etc., used in self-hardening steels, is not considered in the above analysis, as the percentage of tool steel in scrap is extremely small.

The rapid cutting tool steels which are usually hardened in a blast of air, belong to this class and contain from 1. to 20. percent of tungsten, with from .25 to 4.50 percent of chromium.

Unless the tool steel is burnt or otherwise damaged, it would be folly to consign such material in the scrap heap.

An unfinished die found in the scrap heap was analyzed out of curiosity and found to be a superior grade of "high speed" tool steel.

The tool maker evidently did not know how to work the metal and probably condemned it as being no good.

The analysis was as follows:

Silicon	.22	percent
Sulphur	.011	percent
Phosphorus	.011	percent
Manganese	.12	percent
Carbon	.52	percent
Tungsten	18.00	percent
Chromium	3.30	percent

In the analysis of the different kinds of scrap the aim has been to include the variation of extremes, consequently for practical purposes it is customary to add the two extremes and divide by 2 for an average, thus: The variation in sulphur being .025 to .125, the average would be .075 percent, which is close enough for estimating the first mixtures when starting out with a change of scrap.

(8) Wrought Iron Scrap.

There is very little call for this class of scrap. It is used in a limited way in the manufacture of Mitis metal, which once was in demand, but has since been forced aside by the modern steel castings.

The high melting point of wrought iron excludes its use in the cupola, although some foundrymen still use a small amount (20 lbs. wrought iron to 2,000 lbs. of pig), to prevent "kish."

Steel scrap answers just as well and is more easily melted.

The following specification defines the use of wrought iron in the manufacture of re-rolled or commercial refined iron:

Specifications for Wrought Iron Scrap.

The following material will be accepted, viz.: Wrought iron rods, shafts, girders, beams, heavy hoop iron, horse shoes, heavy iron wire, spikes, wrought nails, rivets, bolts, flat wrought bars, and other wrought iron material excepting borings, tacks, nuts, washers, etc.

Steel is not desired, but the material will not be rejected on account of a small amount of steel welded or fastened to the wrought pieces.

Rounds, flats, horse shoes, large rivets, heavy wire, etc., are preferred.

Scrap containing washers in quantity or other small pieces will be accepted only at a reduced price.

General analysis of wrought scrap:

Silicon	.00	to	.15	percent
Sulphur	.008	to	.045	percent
Phosphorus	.011	to	.35	percent
Manganese	.00	to	.10	percent
Carbon	.00	to	.10	percent
Graphite	.00	to	.05	percent
Slag	.01	to	1.20	percent

An ideal wrought iron should be low in everything but pure metallic iron.

With manganese or carbon above .10 percent, it inclines to become steely; sulphur makes it red short, and most specifications limit this element to .04 percent.

Phosphorus should be below .10 percent, carbon the lower the better, graphite is objectionable, and an excess of slag shows that the iron has not been sufficiently worked.

The re-rolled or commercial refined iron made from scrap always contains more or less steel, consequently such iron is higher in manganese, carbon and sulphur than the regular puddled wrought iron.

This material generally has a high tensile strength, but the fiber is poor; it is therefore unsuitable for stay bolts, rivets, etc.

(9) Mixed Scrap.

This class of scrap may contain "any old thing," from tin cans to anvils or cannon.

Such material is usually collected by junk dealers and sorted into the following material: Cast iron, wrought iron, sheet iron, brass and bronze, tinware, lead and similar metals; also steel, providing the junk dealer is able to distinguish it from iron.

The tin is reclaimed from the cans and the remaining iron used for making copperas, melting into sash weights, etc.

The lead and brass goes to the bearing metal or Babbitt maker, while the iron is generally sold to the foundry.

Much of this iron scrap is good, but as a rule it is poorly sorted and consequently contains considerable wrought iron.

General Remarks on Scrap Iron.

At present no fine distinction is made in regard to the classification of scrap by the jobbing foundry, but the large manufacturers are more particular and insist on some form of sorting.

Evidently the tendency is along this line and will eventually result in the scrap being carefully sorted by the scrap dealer, resulting, of course, in a scale of prices according to grade.

Every foundryman is inclined to use scrap, preferring it to grey-forge at the same price.

As a rule a mixture containing scrap produces a stronger cast iron than an all pig mix.

There are several reasons for this, one of which is that the graphitic carbon is in a finer state of division than in pig iron.

Another idea is that the total carbon is reduced by addition of scrap, which acts like steel in this respect.

Steel being free from silicon and graphite, not only reduces the silicon and total carbon in a cupola mixture, but actually favors combined carbon.

If a mixture be made from pig iron only, with, say a silicon content of 1.80 percent, all other metalloids being normal; and another mixture be made of pig with, say 15 percent of steel, the resultant cast iron containing 1.80 percent of silicon and identically the same amount of total carbon, etc., it will be found that the steel mixture will be the stronger, and if heat conditions could be absolutely controlled the combined carbon would be higher.

This experiment has been tried several times and even with the same carbon ratio the steel mix was the stronger iron.

This state of affairs may possibly be solved by means of the microscope, hence the "fineness of division" theory will then be made clear.

The claim is also made that the difference in strength and closeness of grain in castings made from charcoal and coke pig iron is due to the finely divided form of the graphite in the former pig iron.

No matter what the cause, or what theory be accepted, the fact remains that an iron containing scrap will be stronger than an all pig mix.

The whole secret of strength in cast iron is conceded to be due to carbon, and is dependent

upon the ratio of the two forms, i. e., combined and graphitic.

Furthermore this ratio is greatly influenced by the amount of total carbon within certain limits, for example: A sample of cast iron containing 3.50 percent of graphite or graphitic carbon and .50 percent of combined will not have a strength equal to one containing 2.80 percent of graphite and .40 percent of combined carbon, although each one bears the ratio of 1 to 7.

This is easy of solution, for the reason that graphite has no strength of its own and any excess present simply reduces an equivalent percentage of metallic iron.

In the case cited there was a difference of .70 percent; taking 34,750 pounds as the actual tensile strength per square inch of pure metallic iron, .70 percent of graphite would make a difference of about 243 pounds.

When, however, we go to extremes and reduce the total carbon to a minimum the result is a hard brittle iron; on the other hand, an excess of carbon, especially graphitic, produces a soft weak iron.

Repeated melting will reduce both the silicon and the carbon and eventually result in a white iron.

Scrap iron having been melted one or more times is therefore started on this course and would eventually reach the white iron stage if remelted a sufficient number of times.

The regular foundry re-melt, known as "Home Scrap," is preferable to a "Foreign Scrap," as its composition is known and the remelting has not been carried too far.

Good castings with a high strength may be made from an all scrap mix, providing a little ferro-manganese be added as a cleanser and sufficient ferro-silicon charged to make the iron soft enough to machine.

Making an all scrap mix by analysis is a difficult proposition, but it is being done every day and the results are said to be satisfactory.

In conclusion we pray that the "scrap heap" may be more respected in the future, its value be recognized, and the good separated from the bad.

PATTERN INSURANCE.

Memoranda Submitted to the Insurance Interests.

(1) The value of a pattern for record purposes shall be the actual cost to the owner.

(2) That in view of the fact that some patterns are active, some semi-active, others are used for emergencies only, and still others are entirely obsolete; and a division into these desired classes for equitable valuation becomes too much a matter of individual and interested views; the insurance valuation be fixed by an annual depreciation charge on the record cost.

(3) That the depreciation charge for wooden patterns be 10 percent per annum of the record cost, and for metal patterns similarly 5 percent, with the proviso that the depreciation value cannot go below the scrap value of the material.

(4) That in consideration of the heavy depreciation charge provided for, the age of every pattern shall date from the last time it went into the foundry to make a casting therefrom, this record date proving that it must have been in proper condition for work at that time. Active patterns therefore retain their full value, semi-active patterns will be restored to full value every time they are used after being put in order or replaced, and patterns which have been obsolete in the course of time, are dead when ten years have elapsed.

(5) Customers' patterns, being naturally active, or if not nevertheless impose obligations for full payment upon the foundry having them, in case of fire, are not subject to depreciation and their value must be ascertained by the foundryman and noted on the record card when received.

(6) To carry out this line of action, a form of record is recommended as between the foundry and insurance interests, which is to be kept strictly up to date by the founder, and always open to inspection and controlled by the insurance representatives, and upon which records losses are to be adjusted.

(7) That after due discussion and agreement between the two interests, a pattern clause based upon the standards adopted by the American Foundrymen's Association and approved by the National Board of Fire Underwriters, be used and attached to foundry insurance policies, and the 10 percent clause limiting insurance carried on patterns be abrogated with such foundries as conform to the requirements as to systematic valuation and recording of patterns defined in the standards agreed to.

Explanatory Notes.

The repairing of a pattern from time to time, as it requires it, should not be added to the record value of a pattern. Only additions or charges which increase the intrinsic value of the pattern can be added, in which case the original card is destroyed and a new one with the new value made out.

A card record is recommended because it can be kept clear of all obsolete matter, and may easily be locked up in a fire-proof safe every night.

Suitable space shall be left to stamp in dates for depreciation record. Every time a pattern goes into the foundry, its card is stamped with the new date, thus wiping out all the depreciation existing before.

The introduction of this system will be a good opportunity to go through the pattern safe, and remove and scrap all obsolete material in it, starting with a new record. Wherever the date for record of a pattern cannot be located, a value shall be placed on it as it is, and the depreciation record begins from then. This with an exact record of all new patterns made and received will in a few years work out to a reliable and valuable system.

Patterns received from customers should be kept separate from the shop pattern records, so that no confusion may arise. In fact where it is desirable to separate various classes of patterns, it is recommended that the standard size card be kept in different colors. This applies also to wooden and to metal patterns, as the rate of depreciation is different for each class.

While a sample card is submitted for consideration, the American Foundrymen's Association welcomes descriptions of systems which will embody the principles laid down in the propositions between the two interests, and will thus be in position to develop a standard system in all its details.

STANDARD SPECIFICATIONS PROPOSED FOR FOUNDRY PIG IRON BY THE AMERICAN SOCIETY FOR TESTING MATERIALS.

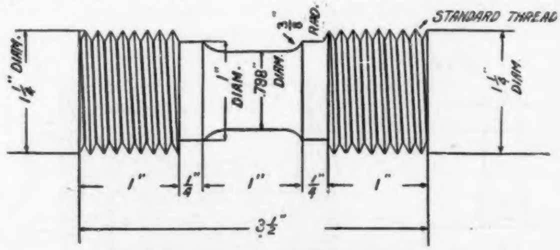
Analysis.—It is recommended that all purchases be made by analysis.

Sampling.—In contracts where pig iron is sold by chemical analysis, each carload, or its equivalent, shall be considered as a unit. At least one pig shall be selected at random from each two tons of every carload, and so as to fairly represent it.

Drillings shall be taken so as to fairly represent the fracture surface of each pig, and the sample analyzed shall consist of an equal quantity of drillings from each pig, well mixed and ground before analysis.

Allowances and Penalties.—In all contracts in the absence of a definite understanding to the contrary, a variation of 10 percent of silicon, either way and of .01 in sulphur above the standard is allowed. A deficiency of over 10 percent in the silicon, up to 20 percent, and a further increase in sulphur up to .01 over the above allowance subjects the shipment to a penalty of 1 percent in the price for each element so affected.

Base Analysis of Grades.—In the absence of specifications the following numbers, known to the trade, shall represent the appended analysis for standard grades of foundry pig



ARBITRATION TEST BOX TENSILE TEST PIECE.

iron, irrespective of the fracture, and subject to allowances and penalties as above.

Grade.	Percent Silicon.	Percent Sulphur.
No. 1	2.75	0.035
No. 2	2.25	0.045
No. 3	1.75	0.055
No. 4	1.25	0.065

Standard Specifications Proposed for Gray Iron Castings.

BY THE AMERICAN SOCIETY FOR TESTING MATERIALS.

Process of Manufacture.—Unless furnace iron is specified, all gray castings are understood to be made by the cupola process.

Chemical Properties.—The sulphur contents to be as follows:

Light castings .... not over 0.08 percent
Medium castings ...... not over 0.10 percent
Heavy castings .... not over 0.12 percent

Definition.—In dividing castings into light, medium and heavy classes, the following standards have been adopted:

Castings having any section less than ½ an inch thick shall be known as *light castings.*

Castings in which no section is less than 2 inches thick shall be known as *heavy castings.*

Medium castings are those not included in the above definitions.

PHYSICAL PROPERTIES.—*Transverse Test.* The minimum breaking strength of the "Arbitration Bar" under transverse load shall be not under:

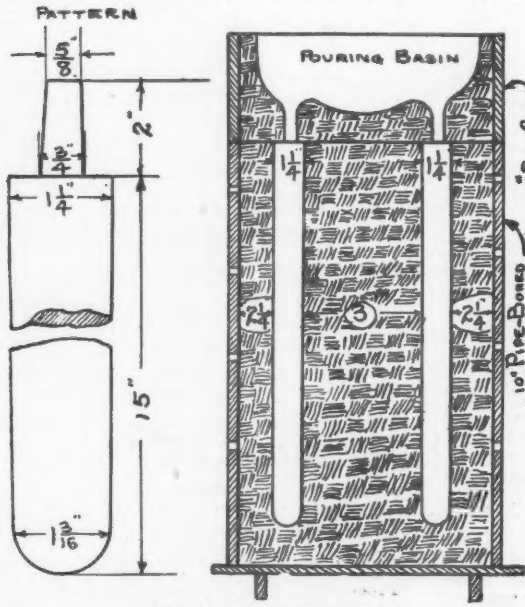
Light castings	2,500 lbs.
Medium castings	2,900 lbs.
Heavy castings	3,300 lbs.

In no case shall the deflection be under .10 of an inch.

Tensile Test. Where specified, this shall not run less than:

Light castings	18,00 lbs. per sq. in.
Medium castings	21,000 lbs. per sq. in.
Heavy castings	24,000 lbs. per sq. in.

THE "ARBITRATION BAR" AND METHODS OF TESTING.—The quality of the iron going into



MOLD FOR ARBITRATION TEST BOX.
Secretary's Note: Illustrations have not been drawn to scale.

castings under specifications shall be determined by means of the "Arbitration Bar." This is a bar 1¼ inches in diameter and 15 inches long. It shall be prepared as stated further on and tested transversely. The tensile test is not recommended, but in case it is called for, the bar as shown in Fig. 1, and turned up from any of the broken pieces of the transverse test shall be used. The expense of the tensile test shall fall on the purchaser.

Two sets of two bars shall be cast from each heat, one set from the first and the other set from the last iron going into the castings. Where the heat exceeds twenty tons, an additional set of two bars shall be cast for each twenty tons or fraction thereof above this amount. In case of a change of mixture during the heat, one set of two bars shall also be cast for every mixture other than the regular one. Each set of two bars is to go into a single mold. The bars shall not be rumbled or otherwise treated, being simply brushed off before testing.

The transverse test shall be made on all the bars cast, with supports 12 inches apart, load applied at the middle, and the deflection at rupture noted. One bar of every two of each set made must fulfil the requirements to permit acceptance of the castings represented.

The mold for the bars is shown in Fig. 2. The bottom of the bar is 1-16 of an inch smaller in diameter than the top, to allow for draft and for the strain of pouring. The pattern shall not be rapped before withdrawing. The flask is to be rammed up with green molding sand, a little damper than usual, well mixed and put through a No. 8 sieve, with a mixture of one to twelve bituminous facing. The mold shall be rammed evenly and fairly hard, thoroughly dried and not cast until it is cold. The test bar shall not be removed from the mold until cold enough to be handled.

SPEED OF TESTING.—The rate of application of the load shall be thirty seconds for a deflection of .10 of an inch.

SAMPLES FOR CHEMICAL ANALYSIS.—Borings from the broken pieces of the "Arbitration Bar" shall be used for the sulphur determinations. One determination for each mold made shall be required. In case of dispute, the standards of the American Foundrymen's Association shall be used for comparison.

FINISH.—Castings shall be true to pattern, free from cracks, flaws and excessive shrinkage. In other respects they shall conform to whatever points may be specially agreed upon.

INSPECTION.—The inspector shall have reasonable facilities afforded him by the manufacturer to satisfy him that the finished material is furnished in accordance with these specifications. All tests and inspections shall,

as far as possible, be made at the place of manufacture prior to shipment.

Standard Specifications Proposed for Malleable Castings.

BY THE AMERICAN SOCIETY FOR TESTING MATERIALS.

PROCESS OF MANUFACTURE.—Malleable iron castings may be made by open hearth, air furnace or cupola process. Cupola iron, however, is not recommended for heavy nor for important castings.

CHEMICAL PROPERTIES.—Castings for which physical requirements are specified shall not contain over .06 sulphur nor over .225 phosphorus.

PHYSICAL PROPERTIES.—(1) *Standard Test Bar.* This bar shall be 1 inch square and 14 inches long, without chills and with ends left perfectly free in the mold. Three shall be cast in one mold, heavy risers insuring sound bars. Where the full heat goes into castings which are subject to specification, one mold shall be poured two minutes after tapping into the first ladle, and another mold from the last iron of the heat. Molds shall be suitably stamped to insure indentification of the bars, the bars being annealed with the castings. Where only a partial heat is required for the work in hand, one mold should be cast from the first ladle used and another after the required iron has been tapped.

(2) Of the three test bars from the two molds required for each heat, one shall be tested for tensile strength and elongation, the other for transverse strength and deflection. The other remaining bar is reserved for either the transverse or tensile test, in case of the failure of the two other bars to come up to requirements. The halves of the bars broken transversely may also be used for tensile strength.

(3) Failure to reach the required limit for the tensile strength with elongation, as also the transverse strength with deflection, on the part of at least one test, rejects the castings from that heat.

(4) *Tensile Test.* The tensile strength of a standard test bar for castings under specification shall not be less than 42,000 pounds per square inch. The elongation measured in 2 inches shall not be less than 2½ percent.

(5) *Transverse Test.* The transverse strength of a standard test bar, on supports 12 inches apart, pressure being applied at center, shall not be less than 3,000 pounds, deflection being at least ½ of an inch.

TEST LUGS.—Castings of special design or of special importance may be provided with suitable test lugs at the option of the inspector. At least one of these lugs shall be left on the casting for his inspection upon his request therefor.

ANNEALING.—(1) Malleable castings shall neither be "over" nor "under" annealed. They must have received their full heat in the oven at least sixty hours after reaching that temperature.

(2) The "saggers" shall not be dumped until the contents shall at least be "black hot."

FINISH.—Castings shall be true to pattern, free from blemishes, scale or shrinkage cracks. A variation of 1-16 of an inch per foot shall be permissible. Founders shall not be held responsible for defects due to irregular cross sections and unevenly distributed metal.

INSPECTION.—The inspector representing the purchaser shall have all reasonable facilities given him by the founder to satisfy him that the finished material is furnished in accordance with these specifications. All tests and inspections shall be made prior to shipment.

MOLDING MACHINES AND THEIR USES.

BY E. H. MUMFORD, PHILADELPHIA, PA.

I have chosen for my title "Molding Machines and Their Uses." It is not my purpose to describe or to advocate any particular molding machine to the exclusion of any. There is use for all. If there is any trade under the sun to which it is impossible to adapt one single machine, or one mechanical process, it is that of molding for metal castings, from patterns as chaotic in outline and dimension as are the brains that originate them, in the one material of the universe, which, from scriptural times on, has been the symbol of instability and fickleness.

When the molding machine art shall at length be finally and fully developed, it is probable that the aggregation of machines responding to its demands will be similar to the disarray of flasks, core arbors, bottom plates, and other bric-a-brac of the foundry of antiquity; and I venture to suggest that some of the machines now heralded as world beaters, and bolstered by everything except success, will be relegated to the stacks of brilliant ideas which, then as now, will occupy dusty and unmarked graves in foundry yards, their fast disintegrating skeletons protruding.

Some things are called molding machines which almost lack the number of parts to comply with the definition, for instance a snap flask and the usual match, with vibrator frame

and a vibrator, is the most universally applicable hand molding machine for small work that I know, yet all that has been added to the flask and the match to make this apparatus a machine is practically one piece, which need not weigh more than six or eight pounds, so far as its operation is concerned. From this to some of the elaborate process machines, which have been developed for molding specialties, the side bays of the foundry are lined with mechanisms, the mere naming of which would make a paper by itself, and yet the field of molding in sand is not more than half explored; and, as one man has put it, the surface of the trade in molding machines has hardly yet been scratched. When it is ploughed, and sown and fertilized, with an intelligent appreciation of what the molding machine can accomplish, and the energy to make it accomplish this, the resulting crop will keep the molding machine factories busy as they never have been; but no one machine will do the ploughing, nor will one man's brains conceive all the machines that will be required.

I make no attempt to illustrate molding machines, for the reason that it evidently would be impossible to illustrate all, or even the types of them; and, in the remarks which follow, I do not mean to refer to the well known special machines which are used for molding such things as cast gears, pulleys, bath tubs, water pipe, etc., for which the machine is built around its work, and in many instances consists largely of the patterns and their special arrangement, as in the case of a pulley machine adapted to molding pulleys ranging in size from, perhaps, 10 inches to 30 inches on the same machine with every conceivable width of face in these diameters, on which the patterns represent, probably, two-thirds of the weight and nine-tenths of the cost of the total machine.

As I have said, the simplest hand molding machine I know is the vibrator frame, with its vibrator attached guided in the pins of a snap flask and used in connection with a match of the ordinary description, whether of wood, metal or a litharge mixture. In such a frame any two part pattern, which would ordinarily be molded in a snap flask, may be fitted and rammed up, cope and drag, by hand. For a flask say 12 in. x 16 in. the total weight of this machine is not more than twenty pounds, including the flasks, and the whole thing can be hung on the wall. Put this with a hand squeezer, and it is still a hand molding machine. Put it with a power squeezer, and it becomes a power molding machine. Strictly speaking, the vibrator constitutes it a power machine, though the ramming is done by hand; but in a foundry where compressed air is piped about the shop (and foundries where it is not are now exceptions) a hose to a vibrator seems hardly a power connection.

Next in point of simplicity, so far as the machine is concerned, comes the hand-ramming stripping-plate apparatus, in which, by many varying forms of linkage, a pattern support is moved vertically, while a frame of some form supports a stripping plate through which the patterns are drawn. The mechanism by which the patterns are manipulated, and the forms and materials in which the stripping plates are made are now very numerous; and, except for the expense of the stripping plate, and the necessity for attaching the patterns to a separate support there is no more generally useful molding machine made. By a slight modification in the construction of the last mentioned hand-ramming stripping-plate mechanism, it is possible to use the same machine for either stripping plate or vibrator molding, according to the nature of the work. Thus a man might have a deep spur gear on such a machine, in which stripping the pattern was a sine qua non; and, the next hour, he might wish to mold on the same machine a crank or a valve, or a valve wheel, and it could be done by attaching half a split pattern to a flat plate resting on the same support which previously carried the stripping plate patterns, and placing on the frame, which before carried the stripping plate, a flask frame containing the guiding pins for the flask. The special construction referred to in this machine is one which differentiates vibrator machines from machines on which vibrators might be used by attaching them to one part or another of the machine, but by which attachment the flask and the mold itself would be as much agitated as the pattern which alone one wishes to affect. This construction, which is fully protected by patents, consists in an independent and elastic support for the pattern, so that this vibration does not extend to the sand, which would otherwise be more or less demoralized in the pattern drawing.

Perhaps, as I have begun with the simpler machines, it would be well to speak next of the "squeezer," as it has been known for years. These machines are so well known and so much in evidence everywhere, and have been for so long in use, that it is hardly more than necessary to mention them. We have all seen the evolution, which it took years to effect, in these squeezers, changing the relatively in-

efficient side lever, nearly vertical in ramming, to the almost ideal horizontal lever, which even a lazy man can make work by sitting on it.

These squeezers have been fitted with auxiliary apparatus, such as stripping plates, flask lifters, variable tucking blocks, and sprue cutters ad libitum, until the hand squeezer equipment seems to have been as intelligently treated as any in the molding machine business. It is not a far step from pulling a lever by hand to making a cylinder do it, and there are now forty or fifty machines in existence in which the operator "presses a button" with his hand and rams the mold, and then presses another button with his knee and draws the pattern. Not more than half the patterns in use may be economically molded by machinery without rolling the drag flask over, and stripping plate and vibrator, hand and power machines of many forms are now made to do this. When a pattern is drawn up there is less excuse for a stripping plate than when a pattern is drawn down, and with four powerful vibrators acting on a follow board, deep and difficult "blind lifts" are easily made.

When stripping plates are used, they may be operated by the machine or they may be left to follow the sand by gravity. Gravity stripping plates are very old, but now and then they are re-invented, much as a new house is made out of an old one by a coat of paint. If the color is sufficiently startling, you forget the old house for your amazement at the new. It is nearly twenty years since a thoughful foundryman jar-rammed the first mold mechanically, and it will not be long before most of the deep machine molding now being rammed by hand is jar-rammed by machine.

I have but skimmed the surface of a wide new landscape, calling attention to a few prominent objects in a "bird's eye view" of the new territory of the molding machine. Foundrymen are watching keenly the development of this, to many of them, yet undiscovered country. They have money to invest; they see wonderful products of the region and wonder what they need to cure them of the tired feeling we all suffer when we see that others are enjoying what we miss.

It is related of John Ericsson that he did not allow physicians to prescribe for him. He would use the doctor's answers to his questions to diagnose his own case. Then, with the entire pharmacopeia applicable to his case symptomatically labeled by the learned man, Ericsson helped himself to his remedy. So, let me suggest that when you feel that you are suffering from what I might call mechanical prostration, you call in the open minded practitioner with no hobby to ride and quacking no patent medicine a cure for all your ills, see what there is to choose from and, diagnosing your own need, make your own selection of apparatus.

Regard whatever money you spend for the purchase of molding machines as only the beginning of your investment. The cost of fitting the patterns to the machines comes after that, and you should not so order your machines as to be obliged to fit your patterns in only one way, and that perhaps, the most expensive and most limited in application. Anyone can buy molding machines. Few use them to the best advantage. Nothing is doing more to develop the mechanic in the foundry foreman than the molding machine, and the success or failure of either today marks the use or fall of both in foundries which should use machines.

PIG IRON WARRANT SYSTEM AND THE FOUNDRY.

BY GEO. H. HULL.

The proposed letting of a contract for a large amount of castings to be used in connection with the Pennsylvania tunnels in New York, deliverable over a period of four years, has for several months been a topic of much discussion among iron foundrymen, and the would-be contractors have found embarrassment over the question of how to protect themselves in making a bid at a fixed price, and for fixed dates of delivery, over so long a period, in face of the well known irregularities which in the United States attend the supply of pig iron, both as to price and deliveries. With the experience of the last five years fresh in mind, during which iron advanced to $25 per ton, and the stock held by the merchant furnaces was on two occasions reduced to less than 50,000 tons, the idea of making a contract for 300,000 tons of castings with fixed dates of delivery seemed like tempting fate.

If, for example, the furnaceman with whom the foundryman made his contract for pig iron should, for any reason beyond his control, be unable to make or deliver the iron at dates specified, and iron should again be scarce and high, it is impossible to tell how serious the result might be. The custom prevalent among foundrymen in the United States of taking contracts for castings, deliverable on fixed dates, over long periods, and of relying for their materials upon a contract with iron producers, containing what is called the strike or accident clause, reading: "Shipments and de-

liveries are subject to strikes, accidents, deficient transportation and all other causes beyond our control," seem to the mind of the Scotch foundryman to voluntarily invite disaster. The possibility of a strike in his own works he recognizes as a risk of his own, and one which he cannot avoid, but the idea of doing business on the basis of assuming everybody else's risk, all down the line, he does not comprehend.

If the foundryman allows the strike or accident clause to be inserted in his contract for pig iron, ordinary prudence would prompt him to require in his contract for castings, and so must each one all along the chain of producers and consumers. Through such a custom, anyone may escape the obligation of making deliveries on time, either through a difficulty at his own works or an interruption in the delivery of his raw materials. When such a condition has become general (and we are drifting rapidly toward it), a labor leader in any one branch of the industries may control all the productive industries of the country. A steamship in progress of building, for instance, would progress toward completion only when labor in all the trades which furnished any material for that steamship graciously permitted it to do so. Labor leaders already have power enough, without any such voluntary aid from employers. Fortunately, it is often impossible for the labor leaders in one trade to induce other trades to join in a sympathetic strike, but just to the extent that employers accept this strike or accident clause, they hand themselves over, "bound hand and foot," to the mercies of the labor leaders of every trade which is in any way connected with their own.

But this is not the only evil encouraged by this strike or accident clause. It is probably the most potent means which could possibly be devised for discouraging the accumulation of reserve stocks of raw materials. If the sellers of pig iron, for instance, were not permitted to embody this conditional clause in their contracts, that is, if the consumer would accept only contracts for iron which required positive delivery at times specified, then the sellers, through ordinary prudence, would be forced to carry a reserve stock sufficient to enable them to make deliveries through any ordinary period of interruptions which might take place in their works; and these reserve stocks, if thus accumulated in every branch of manfacture, would not only be a great boon to all the constructive industries of the country, but they would go far toward discouraging labor strikes within these industries.

The Hon. Carroll D. Wright, United States Commissioner of Labor, when he visited New York in the winter of 1903 as the representative of President Roosevelt to investigate the anthracite coal strike, said to an enthusiastic exponent of the reserve stock system, that if the coal operators in the United States had carried out his theory of accumulating large reserve stocks of coal, there would probably have been no strike. In determining whether to strike or not to strike, the labor organization will first consider its chances of success. In whatever branch of production the strike is contemplated success depends largely upon the reserve supply of the product, immediately involved. If the stock be small, the necessities of the community go a long way toward forcing the producers to resume work, even to the point of conceding to unreasonable labor demands. On the other hand, if the stock is large, that one fact will almost certainly prevent a strike, unless it is founded on some good and sufficient reason.

In this country, under existing conditions, the only way a foundryman can make a contract for a large amount of castings, deliverable over a long period, and be sure of having the required amount of pig iron when he needs it, is to buy it out and out and pile it in his yard at the time he makes the contract. But this would tie up an unreasonable amount of capital, and occup-- too much of the consumer's yard space. The producer, on the other hand, has no incentive to accumulate iron; he may contract his anticipated product for months ahead, deliver it on those contracts as made, and if anything beyond his control prevents his producing it, he is relieved from delivery by the strike or accident clause. He may sell his expected output a year ahead if he chooses, and not be obliged to carry a single ton of stock. What is the result? No one carries any stock which he can avoid, and when each period of prosperity returns to the country the whole fabric of business is hampered, delayed and disorganized by the famine in iron; prices soar to fabulous heights, all other materials follow in sympathy, laborers strike all the way up to get their share of the good times, and afterward, all the way down to ward off their share of the bad times. Eight times within the last eighty years this country has suffered from an iron famine. Everyone who had work which required iron was behind, and the whole business of the country was delayed in consequence of the scarcity of this one article.

If you think I am giving too much importance to iron, remember it is the foundation of all the mechanical industries. Look about you, out of doors or in. Can you see any article of value produced by man which is not fashioned with the aid of iron? The food you eat is cooked in iron utensils; the clothing you wear is woven by iron machinery; it is necessary to every step of man's progress. If you double the mechanical industries, you double the wear and tear of iron and the demand for it. Remove iron, and you paralyze the commerce and industries of the civilized world. Is it too much to say, then, that a famine in its supply, and an advance of 100 percent to 300 percent in its cost will derange and retard the industries of which it is the foundation? There is no other staple which cannot be supplied quickly enough to meet a suddenly increased demand of 100 percent. To meet a corresponding increase in the demand for iron is impossible. It therefore becomes evident that these abnormal and injurious advances can be modified only by producing in dull times a surplus stock as a reserve to supply the demand in active times. It is no more over-production to accumulate during seven or eight years of dullness, enough iron to supply the demand during the succeeding two or three years of activity, than it is to accumulate during the three months of harvest enough grain to supply the demand during the succeeding nine months. It only requires that the mind shall become accustomed to the idea to fully accept it.

For several years previous to 1897 the production of iron in this country was on the plane of about 9,000,000 tons per annum; iron producers were bemoaning what they called over-production, and furnaces were often banked to curtail production, although the reserve stock was only 500,000 to 1,000,000 tons. Since that time, events have shown that if the reserve stock had been 37,000,000 tons, and the furnaces had continued to produce 9,000,000 tons per annum, it would by this time all have gone into consumption. Think of the absurdity of crying over-production, with but 1,000,000 tons of iron in stock, on the eve of a period of prosperity which required an additional supply of 37,000,000. Is it any wonder that the stock during the last six years has often been down to less than a day's product, and that the iron consumers suffered?

If the consumers of this country are in the future to be protected as to their supply of iron, they must protect themselves as is done in Scotland. They cannot expect the producers to do it for them. If the producers sell them iron deliverable six or twelve months ahead, they must either protect themselves by storing the iron or demand a contract with the strike and accident clause. No prudent furnaceman would do otherwise: and yet to continue the present custom is to insure a continuance of the known evils of the past.

A contract with the strike or accident clause is worse than no contract at all. It is a promise with an "if." When the "if" is not called up, you would do as well without the contract as with it. When the "if" is called up, you are left in a tight place, with no one under obligation to help you out. Without such a contract you would probably have bought and piled up the iron to protect yourself. Of all the delusions and snares which attend the business systems of this country, I know of none in appearance so harmless, and yet so blighting in effect.

What the foundryman in the United States most needs is a system whereby he can purchase his iron at a fixed price, and far in advance, with the certainty of obtaining it when needed without tying up his working capital; and without piling up a surplus quantity of iron in his own yard. The Scotch warrant system has satisfied this same need in a perfect manner for 50 years, and it is for this reason that it has become the established system of that country.

In Scotland, when a foundryman takes a contract for a large amount of work, deliverable over a long term, he goes directly to a warrant dealer and makes a contract for warrants for a corresponding amount and time of delivery; these contracts have no strike or accident clause; they are positive and must be kept, or the seller must suffer the loss entailed. A warrant dealer in Scotland will sell protection to a consumer for five years ahead just as readily as he will for six months or a year. The charge he makes for such protection is based on what it will cost him to buy iron by warrant the day he makes the contract, and carry same to the dates of deliveries called for by the contract. When the warrant dealer enters into a contract to protect a consumer in this manner, he must necessarily buy warrants to protect himself, and as long as the contract of protection runs, he must own and carry warrants to protect himself. By this system the capital and space necessary for perfect protection to the consumer is provided at a reasonable cost and without his depriving his business of either capital or yard space required The establishment of the warrant system was

as great a relief to the iron producers and consumers of Great Britain as was the establishment of the national banking system to the financial exigencies of the United States. One created a demand for bonds which had never before existed, the other created a demand for iron which had never before existed; one necessitated the carriage of bonds by every national bank, the other necessitated the carriage of iron by every warrant dealer. It is through this necessity for carrying a reserve stock that Scotland accumulates six to twelve months' supply of iron, while the United States accumulates but three to six weeks' supply.

How are the American foundrymen to bring about in this country the conditions existing in Scotland? I presume Americans will have to bring it about substantially just as the Scotchmen did; that is, they will, in the beginning, have to buy and carry warrants as a reserve stock, until the business of selling protective contracts becomes an established business among iron dealers. To begin with, we have already in existence the American warrant. This warrant is simply a negotiable warehouse receipt for pig iron, which describes the brand and quality of the iron, as well as the location of the yard in which it is stored. Warrant iron is graded either by analysis or fracture; when by analysis, it is according to the rules adopted by the American Foundrymen's Association and the American Society for Testing Materials. Each warrant is for 100 tons of 2,240 pounds, and the warrant company is responsible for the brand, grade and weight described on its face. Every warrant is registered by a trust company of high standing, and no iron can be delivered from warrant yards without the signature of the trust company, and the president and secretary of the warrant company. Money can be borrowed upon them in every large city in the United States, Canada and Great Britain.

In Scotland, at the start, foundrymen who made large contracts for work, bought and carried warrants to protect themselves. By this means they held a reserve supply which was always available in an emergency. Firms of large responsibility found it easy to carry these warrants in banks, but it was not so easy for the small and less responsible ones who needed the protection just as much as the large ones. Through this condition iron dealers commenced to make future delivery contracts for warrants with the consumers. When the dealers entered into these contracts to protect the consumer they bought iron warrants to protect themselves. This business proved so acceptable to all parties that it grew rapidly and soon resulted in large carriage of warrants. Thus the system came into existence in Scotland in a natural way.

If the foundrymen of this country would introduce the Scotch system and thus obtain certainty instead of uncertainty in their iron supply, they have only to refuse to accept contracts with the strike or accident clause, and if in the beginning they cannot procure binding contracts, then buy and carry warrants themselves as a reserve. Just as soon as the sellers realize that the consumers will buy only by positive contracts, they will be ready to sell them in that way. When this is done, however, the consumers must recognize the fact that whosoever sells the positive contracts takes a risk, and is giving the consumers a protection which is of value, and for which they must be willing to pay a reasonable amount just as they do for marine or fire insurance. The little they pay for it will be returned ten-fold in time.

There is an impression among many that in Great Britain consumers purchase the iron they consume by warrant. This is a mistake. Consumers there buy nearly all the iron they use from the makers or their agents, precisely as they do in this country. The warrants which the consumers contract for as protection are to them nothing more than protection. As the months roll by, they purchase the iron or steel they wish for their work of the brand, quality and shape they require, from whosoever will make the most satisfactory terms, and simultaneously sell on exchange an equal quantity of warrants. If iron has gone up, say, 20 shillings, they pay that much more for their material, and get about that much more for their warrants. If iron has gone down, say 20 shillings, they buy their material for that much less, and get about that much less for their warrants. In this manner they eliminate every speculative element from their business and thus insure their legitimate business profits.

Statistics show that the population of this country not only increases enormously, but the consumption of iron per capita increases at a cumulative rate. We consumed about 100 pounds per capita in 1855; 300 pounds per capita in 1890, and 500 pounds per capita in 1902. It further appears that this two-fold increase doubles the country's consumption about every ten years, but the yearly increase is not proportionate. For seven or eight years consumption remains practically on an even plane; then it receives an impetus which causes it to be doubled within two or three years, during

part of which time we experience what has been designated as a pig iron famine. After such periods of famine, the succeeding seven or eight years of dullness and plenty has heretofore lulled us into a delusive feeling of security.

For forty years the late Hon. Abram S. Hewitt predicted these enormous increases, and they have always been verified. Recently the Hon. Edward Atkinson has predicted that the consumption of iron in the United States will reach 40,000,000 tons per annum between 1910 and 1913. This prediction, like those of Mr. Hewitt, is not a fanciful outburst of imagination; it is simply the result of a mathematical calculation based upon the exact growth of the past, and its fulfilment is as assured as is the future growth and expansion of the country. The law of supply and demand is inexorable. The supply of iron for any given period is the stock on hand at the commencement of that period added to the current production during the period. If in 1910 the stock on hand is one million tons, the production eighteen millions, and the demand forty millions, then the supply will be twenty-one million short of the demand the first year of the boom, and no human power can prevent another iron famine.

The past we cannot revoke, but we may profit by its lessons. If we permit the same conditions which have existed for the last eighty years to continue, we will experience the same results. The year 1897 seems a very little while ago; to 1910 will be a still shorter period—hardly time to prepare. If we are to be ready for the next boom, we cannot commence too soon or work too fast. Those who are the first to adopt the Scotch method will get the greatest benefit from it, and when the next period of scarcity and high prices comes, if there are any who have not adopted that system, they will be handicapped, for what iron there is on hand, and what is produced, will naturally go to the consumers who hold binding contracts, in preference to those who hold contracts with the "strike and accident" clause. If, on the other hand, all consumers should from this time on decline to make other than positive contracts, and when the next season of prosperity comes we will be equipped with an ample stock of iron. The famine in supply, arbitrary labor strikes, and advances in prices will be prevented, and thereby insure your ability to supply the demand of the country with promptness, with comfort and with profit. The extra demand created in gathering the reserve supply will be a benefit to producers while it is being accumulated, and to consumers while it is being used.

This question is not only one of great importance to the consumers of this country, but it is one that vitally affects our foreign trade. As long as this country fails to carry a large stock of pig iron, her foreign trade in iron and steel will be subject to interruptions. In 1895 the United States commenced to export pig iron, and inside of three years this business grew so rapidly that she was exporting iron to all the manufacturing countries of Europe. When prosperity returned in 1899, the relation of supply and demand in the two countries resulted in an advance of 300 percent in the price of pig iron in Alabama against 65 percent in Glasgow. The result was that the export business which we had built up in pig iron was wrested from us completely by Germany and Great Britain.

For fifteen years the average stock of iron carried in the United States has been less than three week's product. During this same period Scotland has carried more than six months' product. Think of the United States attempting to control the iron trade of the world with a stock equal to less than twenty-one days' production.

MOLDING MACHINES OF TODAY.

BY HERBERT M. RAMP, SCHENECTADY, N. Y.

There is probably no question of greater importance in the foundries of today than the use of molding machines, and their adaptability for use on different classes and grades of work. They have become a fixture, and a part of the equipment of the iron foundry that is both necessary and essential for the cheap and rapid production of castings. No foundry can afford to neglect their use in some form if it expects to compete in business. And furthermore it is not the intention in this brief article to discuss ancient methods or practices, but to try to show what developments have been made in the molding machines of today over those of a decade of years ago.

Dating back probably one hundred years, or close thereto, the first attempt to aid the hand work of the molder was the stripping plate device, which has held its position in the trade to some extent ever since, but it cannot be truly called a molding machine any more than an ingenious arrangement of flasks, follow boards or patterns can be. It is simply a device given to the molder to assist in a safe and rapid manner the drawing of the pattern. But

its use has been multiplied, and it has been attached to many other molding machines as an accessory to the greatest economy in production.

Following upon this came the question of disposing of the hard labor of ramming up the molds, which in plain or ordinary castings is the most serious item in limiting production, and power rammers of various types were constructed to meet this requirement. They have been operated by all kinds of power—friction, steam, compressed air, and hydraulic—but it is safe to assume that the hydraulic and compressed air machines lead the procession. The market today holds a number of machines of these types that have been well proven.

From this point it was only a step to apply the stripping-plate arrangement to the power ramming machine, which makes a combination that in some instances is very valuable. But the ramming of molds by power, if only one device is used, is applicable to more classes of castings than the stripping plate device.

The stripping plate machine means expensive patterns and absolutely accurate equipment to realize its true value, but the power rammer can be used on any kind of pattern, iron or wood; if it is irregular in shape it can be fitted to wooden follow-boards at one-twentieth the cost to fit up on a stripping plate machine. With the so-called stripping plate machine it costs from one-quarter to one-half the value of the machine to fit up every set of patterns, while with the power rammer twenty to thirty sets of boards can be fitted up for the same amount, with an equal or greater saving accomplished through the function of power ramming than the finely finished pattern. For this reason it is more valuable for general work, where the patterns are apt to be changed or where only a few of each are required.

The power rammer removes the hard and laborious part of the toil, and fits the operator to produce more castings, while the stripping plate machine simply assists in making a perfect casting and getting a perfect draw. Each has its field and its benefits, but the power rammer unquestionably will save more dollars and cents on the average grade of work than the stripping plate device, besides being far more economical to equip to receive the return from the investment.

Further than this, the loss in castings made on power ramming machines is a great deal less than the loss on stripping plate machines, for a power rammed mold will be rammed more evenly and uniformly than it is possible to ram by hand, with the consequent result that the castings will be true to the pattern and not so subject to scabs, swell, and blows. The old narrow-pointed rammer is kept away from the pattern.

Again the power ramming machine does not require the bars in the flask and the "tucking" of the same, and the setting of endless gaggers and nails that a hand rammed mold does, unless the flask be very large; for the mold can be pressed so much harder than it can be rammed and pressed in that part of the mold where no ill-effects will be felt. The power rammer, with the various attachments, stripping plates for very complicated pieces, vibrators for plainer ones, can be operated with a less intelligent class of labor than the hand ramming machine alone.

There are two distinct types of power-ramming machines built and on the market today. One that rams with a blow; the other with a pressure, or squeezer. On small flasks there is very little to choose between them; both appear to do the work equally well, but on flasks over 20 inches square there is absolutely no question as to the superiority of the machine that rams with a squeeze over the machine that strikes a blow. The reasons for this are obvious. When a flask reaches a size of greater than 20 inches square, or 24 long, the power that is required to ram it is enormous, and the jar that the flask and pattern must sustain is too great, unless heavy equipment is prepared. The flasks will spring, or the pattern, if it is wood, will be forced out of shape by the sudden shock, and when the pattern is drawn it is about an even chance that the mold will fall out when the tension is relieved. With the steadily applied pressure or squeeze these conditions do not obtain. Then, with the blow there is no way to determine how hard you have rammed a mold until it is lifted off, but with the squeeze a gauge can be located directly before the operator's eyes, and he can press the molds exactly with the same pressure every time, and with the pressure that experience has taught him as necessary for cope or drag.

Another point of equally great importance in this connection is this—the machine that rams with a blow when the flask passes 20 inches square in size must be fitted with bars. Otherwise the shock or repeated blows disturb the packing of the sand, and will cause the mold to fall out. With the squeezer the size can be extended up to flasks 30 × 48", and used

without a bar in them. This is an advantage not to be despised.

These things, taken together with the fact that it takes less power to operate a squeezer than it does a machine that rams with a blow, especially if more than one blow is used (and the writer has never witnessed a 36 × 36" blow machine ram a flask with one blow), constrain me to say that the steady pressure or squeeze for molds over a certain size is a thing not only to be desired, but in every way preferred.

On the small power machines the use of the vibrator is unexcelled, and nearly every casting made on a stripping plate machine can be made equally as well with this device, but on the larger machines the question of some facility to draw the pattern is not of great importance, for the time consumed in drawing a pattern that is only used five or ten times a day is a very small item, indeed, against that where a pattern is drawn from 50 to 200 times daily. The vibrator has its field and holds it, but its field does not extend to large patterns or to large machines.

Of the squeezer type there are two machines to my knowledge on the market that even go farther than all the rest. The time consumed in pressing a mold is very short, and nine-tenths of the time a machine stands idle while the operator is performing other necessary functions. With this in view several machines have been designed so that two or four gangs of men can use the same press; the molds enter from the four corners or the four sides. In this way one expenditure for a machine will represent two or four times the output of the one gang type.

Many machines for special work have been equipped still farther with labor saving devices. Some have been built with hoppers over them, with conveyors to carry up the sand and discharge it into the hopper, so that the operator can fill the flask in an instant. Trolley tracks or light cranes have been placed over the larger sizes to handle the flasks, both empty and finished, to pour off with, and a number of other simple devices. The machines have made records which appear almost impossible.

The writer does not feel that there is any limit to the size the power ramming machine can be built and operated successfully. It is simply a question of building the flasks strong enough and of fitting the bars into them in one of several ways. It is my belief that the future will see us building molding machines to squeeze flasks five and six feet square as a very ordinary proposition.

Farther than this I believe that the variety of sand handling appliances will be multiplied, and that more machinery and more labor saving devices will be introduced into the foundry during the next ten years than have been in the past hundred.

The writer offers these few suggestions, from his experience in having charge of a foundry that operates 60 power ramming machines, from 12 × 13" to 30 × 48" in size, and 50 stripping plate, machines from 12 × 12" to 42 × 84", all in operation.

SULPHUR IN PIG IRON.

BY R. S. MACPHERRAN, MILWAUKEE, WIS.

I will start with the explanation that this is not intended as a criticism of Mr. Porter's paper on Irregularity of Sulphur in Pig Iron, but merely in the endeavor to collect some of the published and unpublished information on "Pig Iron Sulphur." Originality is not claimed for a large part of what follows.

In brief, variations in analyses are usually due first to variations in taking the sample and second to variations in methods of working them. The importance of taking a fair sample has often been pointed out, but never more clearly than by Mr. Cooke in his article read before the last meeting of the American Institute Mining Engineers. He shows serious variations to occur between pigs taken from the same cast: for example silicon 1.22 to 1.48 and 1.25 to 3.30. Sulphur .048—.074 and .014—.075.

These seem to be exceptional differences and may have been due to irregular working of the furnace resulting in a lot of mixed iron in the hearth.

We, at one time, took four samples at intervals during the cast for a series of over thirty casts—working each for silicon and sulphur. The variations while noticeable were in no case so great as those mentioned.

Mr. Cooke seems to incline toward a shot sample emphasizing the ease of getting an average silicon, but passing over the consequent lowering of the volatile sulphur. However, in the one high sulphur cast he reports, the shot sample is .054 and the average sand .061.

In the experience of one laboratory sixty samples of shot iron ran average sulphur .044. The average of the corresponding sand samples, sulphur .054.

To confirm these results Mr. M. J. Moore, Jour. Amer. Chem. Vol. 21, page 973, in a series of shot against sand samples of cupola

metal shows the shot to average .018 lower than the sand samples. That this difference between sand and shot is not caused by oxidation of the latter during the pouring is shown in this article by the gravimetric results on both agreeing. That it is not caused by increased insoluble sulphur has been proven by a series of twelve samples resulting:

Shot volatile.... .047 Insoluble.. .0032
Sand volatile.... .055 Insoluble.. .0039

There is evidently some sulphur volatilized but not as H_2S. What this is, is uncertain (possibly a compound with carbon) but it is not absorbed by ammonia or potash.

The tendency, at least in the west, is toward a number of sand samples taken at intervals through the cast.

The next important thing after getting the average pig is to drill it in the place of average contents. This seems in general to be half way between bottom and top and half way between the center and outside. I would in this connection call attention to the article by Guy R. Johnson in the A. I. M. E., vol. 27, page 243. The results there given show quite as serious a difference as do those of Mr. Porters. The greatest difference of opinion and practice seems to be on what allowance to make for residual sulphur. It is the custom in some labratories to add nothing, others add .01, and many use the American Foundrymen's Association standard, which adds in effect 47 percent of the volatile. It seems to me that in case of dispute the only correct way is to refer to a gravimetric method.

It has long been recognized that the ordinary volumetric sulphur is merely a running jump at the truth. We may strike it and may not.

Annealing the samples has been adopted in many laboratories and on the irons we get, works very well. It is to be hoped that our committee on methods have given it a thorough trial on varied work and find they can set their seal of approval on it.

The average of 114 determinations of volatile and insoluble sulphur resulted as follows: Volatile, .045; insoluble, .003. There seemed to be no connection between the total and the insoluble often the hignest volatile giving the lowest insoluble and vice versa.

Mr. Moore, in the above mentioned series on sand cast cupola metal, found the average insoluble to be .008 with a difference of .005 between the total volatile plus the insoluble, and the gravimetric result. This may be due to the organic compound above referred to.

With the above in mind I wish to enter protest against the recommendation by this Association of American Foundrymen's Association sulphur standard "in cases of dispute."

No pig iron standard run volumetrically can give close results on all other pig irons. The A. F. A. standard most in use running volatile sulphur .038, residual .018, total .056.

As I understand its use, the iodine solution is so made up that it will take 5.6 c c to titrate (or neutralize) the volatile sulphur from a five gram sample. It will be seen that the residual sulphur in this iron is 47 percent of the volatile, and that in using it as above, we assume that this is always true. In effect, therefore, we take the observed or actual volatile sulphur and multiply it by 1.47 and call the product the total sulphur.

The use of this standard will give close results on samples with that same percentage of residual sulphur, but if used on an iron with little or none will work a serious injustice. For example some of our local iron contains but .002 to .006 residual. An iron of this kind running in volatile sulphur .038, would be reported as .056 total, where the actual total might be but .040 to .044.

It seems to me that every pig iron should be judged by itself and have its residual sulphur actually determined and that the practice of measuring or estimating the residual sulphur in one iron by that contained in another is not one to be recommended in cases of dispute.

Much of the above work was done in the laboratory of a company by whom I was then employed. I regret that their request, not to give their name, makes it impossible for me to accord them proper credit.

BY-PRODUCT FOUNDRY COKE.

BY CHR. SCHWERIN, MILWAUKEE, WIS.

The rapid increase in the quantity of retort-oven or by-product coke being manufactured in this country, is the excuse for the following few remarks on the process of its manufacture and its utilization, particularly for cupola purposes.

The process of coking coal in such a manner as to utilize the products of distillation, as tar, ammonia, gas, etc., had its origin in Europe, where, due to the deepening of the mines, the comparatively limited supply, and exhaustion of some of the fields of coking coal, it was recognized that something should be done to economize nature's gifts.

In the ordinary Bee Hive coking process the only product of the coal that is utilized is the residual coke left in the oven after the volatile

constituents have been driven off. These volatile compounds simply dissipate themselves into air and all the benefits which might be derived from them are lost to mankind forever. Contemplation makes one marvel at the stupendous amount of energy being constantly wasted —energy which has been stored up for ages— and can never be replaced. The value of this lost material annually amounts to millions of dollars.

In the retort-oven process all these constituents are recovered, and instead of, as some people think, the quality of the coke being injured, it is, on the contrary, superior as a rule. Coals which cannot be made use of in the Bee Hive process often make excellent cokes in the retort oven. In fact, one of the first uses to which this latter type of oven was put was in making coke out of European, hitherto non-coking, coals. On consideration of these facts the conclusion one naturally reaches is that, if a satisfactory coke may be obtained by the retort-oven process why should it not be utilized, and all the valuable material saved which is now being so lavishly wasted.

The first by-product ovens in the United States were those completed in 1892 at Syracuse, N. Y., for the Solvay Process Co. These twelve ovens in 1894 produced 16,500 tons. Since then a large number of plants have been erected and the yield of coke from by-product ovens has increased enormously, amounting to 1,403,588 tons in 1902. Further plants are in process of erection and one of the eighty ovens with a production of 450 tons of coke daily has just been completed in Milwaukee.

In the by-product process coal is so coked that the gases driven off may be led through suitable apparatus for the extraction of tar and ammonia compounds. After these have been removed a portion of the gas is returned to be turned in flues running between the oven walls, thus furnishing the heat necessary for coking further charges. The remainder of the gas is utilized for generating power, heating furnaces in manufacturing plants, for ordinary household fuel purposes and, in a measure, for lighting, as at the Everet plant of the New England Gas & Coke Co. The ammonia is utilized for making soda, ammonia compounds and fertilizers. The tar is used for the manufacture of coal tar compounds, and for making roofing pitch, tar paper, creosote oil, etc.

The following is a brief description of Solvay ovens, this type being described as the writer is more familiar with it, and with the coke made from the same, than he is with the other by-product processes.

The ovens themselves are rectangular in shape, like a flat box standing on edge; the dimensions vary from fifteen to twenty-four inches in width, five to seven feet in height, and around thirty feet in length. The walls are built of specially fitted brick. The ends of the ovens are closed by doors which work up and down. When these doors are down and properly luted with clay no air can enter the retort chamber.

All heat necessary for coking is furnished, as mentioned previously, by the gases which are burned in flues running parallel with the walls and outside of them. The quantity of gas and the air admitted for its combustion can be easily varied, so that a close regulation of the heat may be obtained, thus enabling the coal to receive a uniform coking temperature. The coal never comes into actual contact with the flame. This is a great advantage over the Bee Hive process.

The coal for charging the ovens is brought from stock piles by suitable conveying apparatus, and dumped into them from larries running above. After the proper quantity of coal has been put into the ovens it is carefully leveled off by hand. Coking proceeds rapidly and where in the Bee Hive process seventy-two hours are considered necessary to produce a strong foundry coke, in the Solvay process a structure equal to the most rigid requirements may be obtained in from twenty to twenty-four hours; in the Otto-Hoffman ovens the time is somewhat longer.

Probably several of the reasons for the structure being more quickly obtained in the by-product process than the Bee Hive, is that coking proceeds far more rapidly and uniformly, also, in the Bee Hive process the layer of coal is only eighteen inches deep, while in the retort-oven process it is from six to seven feet, a feature that tends to compress the coke while it is being produced. In addition, the coal is pulverized before being charged into the ovens, and this helps materially.

After the coal is completely coked, both end doors are raised and the charge is pushed out by an electric ram. As the coke slowly emerges from the ovens a stream of water from overhead strikes it as it falls into a steel quenching car which runs on a track below the oven level. Just sufficient water is added to quench the coke and yet leave it almost free from moisture. By the time it is dumped out of the quenching car the residual heat in the coke is found to have evaporated the excess water.

Before citing results and actual figures of cupola operation in which by-product coke has been used it might not be amiss to mention a few of the prejudices against it that are sometimes necessary to contend with. Here is the way one melter put it: He said to his foreman that if he had to use "that dirty, black stuff" he would quit first. The management insisted that it be used and now the melter swears by it and not at it. Another man said his cupola was too big to use by-product coke and that he did not think it would stand up. He would not make an attempt unless he was guaranteed against all loss which might be occasioned due to the coke. After using it for a while he thought it was just right. Still another superintendent, after the receipt of his first by-product coke, telephoned in that he would not use it unless the coke company's representative took charge of the cupola and guaranteed all loss. This same man, after a trial heat had been run, again telephoned that he had examined all the castings and found everything perfect.

It is a common thing to have by-product coke condemned on its looks and recommended on its work. The manufacturers of by-product coke are working strongly to overcome this natural but unreasonable prejudice, and are continually demonstrating that for foundry use nothing can beat a good by-product coke.

Many foundries have been using by-product coke for years with excellent results. However, it may be interesting to see some exact figures on some very recent tests, conducted by the writer, of by-product coke from Milwaukee:

Tests Nos. 1 and 2 were run at the West Allis shops of the Allis-Chalmers Co. Test No. 3 was run at a stove plate foundry, and test No. 4 at a shop making a large number of hot air registers of fancy design. As is well known, these are very difficult to run unless the iron is very hot and fluid. These tests were run in competition with exceptionally good grades of Connellsville coke. The speed of melting was in favor of the by-product, also the sulphur was considerably lower than in Connellsville; as is well known, better castings can be produced from low sulphur coke. Another advantage of low sulphur coke is that a larger quantity of scrap may be carried in the mixture if so desired

Those looking over the following figures will please bear in mind that all coke and iron were very accurately weighed. Many a foundryman will find upon investigation that vastly larger quantities of coke are going into his cupola than are ever reported to the office. Very frequently indeed has this fact been impressed upon the writer when conducting comparative tests. In fact, it is only within the past few weeks that it was found that the office of a certain foundry was getting daily reports showing that the melting was being done with from one hundred (100) to one hundred and twenty (120) pounds of coke on a charge. Upon investigation, however, it was found that the usual practice had been to charge from one hundred sixty (160) to one hundred seventy-five (175) pounds. This fact was quite a surprise to the management. The reason the writer brings this point out so strongly is, that when something new is tried it is usually closely watched, and if it is found that a larger quantity is necessary to do the same work than was hitherto thought to be the practice, the new article is condemned, when in reality there might be no basis for such condemnation.

RECORD OF TEST NO. 1.

Inside dimension of cupola........ 72 inches
At melting zone .... 69 inches

	Lb. of coke.	Lb. of Iron.
Bed charge	3,300	10,000
Charges No. 2 to No. 26 inclusive	550	5,000
Extra coke used during heat	575	.....
Total............	17,625	135,000

Time from blast on until first tap, 20 minutes.

Time from first tap until last iron, 3 hours, 40 minutes.

Pounds of iron melted per hour, 36,800.

Ratio of coke to iron, exclusive of bed, 1 to 8.65.

Ratio of coke to iron, inclusive of bed, 1 to 7.62.

The iron was very hot and fluid, hotter towards the end of the heat for pouring comparatively light finished castings.

RECORD OF TEST NO. 2.

Inside dimension of cupola .... 72 inches
At melting zone .... 69 inches

	Lb. of coke.	Lb. of Iron.
Bed charge	3,300	10,000
Charges No. 2 to No. 31 inclusive	550	5,000
Extra during heat...	600	.....
Total............	20,400	160,000

Time from blast on until first tap, 20 minutes.

Time from first tap until last iron, 4 hours, 30 minutes.

Pounds of iron melted per hour, 35,500.

Ratio of coke to iron, exclusive of bed, 1 to 8.77.

Ratio of coke to iron, inclusive of bed, 1 to 7.84.

Temperature of iron perfectly satisfactory.

Castings poured from these two tests varied from light valves to an engine bed weighing 30 tons.

RECORD OF TEST NO. 3.

Inside dimension of cupola	48 inches
At melting zone	46 inches

	Lb. of coke.	Lb. of Iron.
Bed charge	1,000	2,200
Second charge	110	1,100
Third charge, Fourth charge, Fifth charge, Sixth charge,	105	1,100
Seventh charge, Eighth charge, Ninth charge,	100	1,100
Tenth charge	130	1,100
Eleventh charge, Twelfth charge,	110	1,100
Thirteenth charge	110	1,180
Total	2,290	15,480

Time from blast on until first tap, 10 minutes.

Time from first tap until last iron, 1 hour.

Pounds of iron melted per hour, 15,400.

Ratio of coke to iron, exclusive of bed, 1 to 10.38.

Ratio of coke to iron, inclusive of bed, 1 to 6.8.

The iron was very hot and fluid. Some very light and difficult stove castings were run during this heat.

RECORD OF TEST NO. 4.

Inside dimension of cupola	45 inches
At melting zone	45 inches

	Lb. of coke.	Lb. of Iron.
Bed charge	1,350	4,000
Charges No. 2 to No. 6 inclusive	300	3,000
Charge No. 7	180	1,800
Total	3,030	20,800

Time from blast on until first tap, 22 minutes.

Time from first tap until last iron, 1 hour, 8 minutes.

Pounds of iron melted per hour, 18,300.

Ratio of coke to iron, exclusive of bed, 1 to 10.

Ratio of coke to iron, inclusive of bed, 1 to 6.8.

Temperature and fluidity of iron were satisfactory.

Three hundred pounds of coke were actually put into the cupola on the last charge in order to take care of a full charge of 3,000 pounds of iron: however, only 1,800 pounds of iron were charged on it.

In looking at these tests it must be borne in mind that no attempt was made to break a record for low coke consumption. In every case the object aimed at was primarily to obtain hot, fluid iron adapted to the work and to get at least as good a ratio as had been customary at the plants where these tests were run.

SHOT IRON.

BY JAMES BOYLE, SALEM, O.

This subject is an old one, but it has been brought right home to us lately, as we have installed a wet grinder for crushing and washing our daily cupola dump. The product from this grinder has been a surprise. The amount of clean iron reclaimed daily is so great that we feel assured it pays for the expense of grinding it. During April of this year the amount of clean shot, with many good sized nuggets in each barrowful that we reclaimed daily was over 1,200 pounds.

This is too much iron to throw away, although it is being done by a large number of our foundries. While it seems an easy matter to just charge it into the cupola as scrap, our experience and perhaps that of everyone else is that it is a hard problem to solve.

At first we began to use the shot iron this way: On each of the last two charges of the daily melt we put 500 pounds shot iron. We put it in loose on top of scrap iron, in addition to the regular charge, without any change of kind or amount of pig iron or scrap in the charge. We added extra coke to melt the additional weight.

The result was without any apparent effect on the looks of the castings. For several days we began to think it an easy matter, but from reports that came to us from the machine shop, our first conclusion was dispelled, and before we were through, we found it about as hard a nut to crack as were some of the castings to drill.

We then cut out of the last two charges 500 pounds of scrap iron; in its place we put 500 pounds of shot iron, and on top of this we put 500 pounds of soft silicon pig iron. We took care to pour this mixture into heavy work, with better results, but the shot would show itself, although it apparently melted, and we poured it without trouble. A singular result during this stage was apparent in some wheels poured with iron in which was some of this

shot mixture. One wheel 10 feet in diameter, 14 in. face, with rim 4 in. thick, 11,000 in weight, poured through hub and arms, was a good sound casting in every way, but when face of rim was turned off, groups of bright spots the size and shape of the shot iron, were bunched at and near the middle of the rim, mostly opposite the arm of the wheel, with a few stray spots above and below the center. At top and bottom of rim no spot appeared, and the iron there was our regular blue color. The wheel was soft enough to turn off easily and no difference in cutting qualities was noticed between the bright spots and the regular blue iron. I can not explain why these spots were bunched in that manner.

We now began to use more shot iron. We made an extra charge above our daily wants of soft pig and shot iron—equal parts of each—which we poured into pigs. In following heats we ued this "shot pig" in our cylinder mixture. The result was better, but castings poured from same ladle would sometimes be of different grades of softness.

From the trials we have made of this side issue, we have found the following to produce the most satisfactory results: It is best to charge shot iron in center of the cupola with pig or scrap piled around it forming a nest.

Shot reclaimed from dump in which there is a large proportion of slag, is not worth the trouble to use. It reproduces so much slag in cupola that it is extra work to overcome its effects. We cart away all the slag we can pick out of the daily dump.

It pays to riddle the shot iron. We use a No. 6 riddle—the smallest pieces we put with the machine shop turnings for sale and we use only the larger shot.

We find that to put on top of the shot charge of 1,000 pounds, about 40 pounds of carbide of silicon helps to reduce the hard and non-mixing effects.

We had the best results pouring heavy work with this shot mixture. In small work it seems to chill so quickly when it comes in contact with the damp mold, and runs hard in lugs and projections reaching into the cope of flasks.

As yet we do not charge the shot iron into the cupola with the assurance we would like. That there is a way to do it we feel certain, but we have not yet solved the problem to our entire satisfaction, and we would be very glad to hear from some of the older and more scientifically equipped foundrymen.

Indenture Papers for Apprentices.

The American Foundrymen's Association has recently gotten out forms for indenture papers for machinery molders' apprentices, bench and brass molders' apprentices, and agricultural and stove molders' apprentices. As gotten out by the association, the first mentioned are printed on blue paper, the second on white, and the third on yellow, so that they can be distinguished at a glance.

The text of these indenture papers is printed below, so that any firm desiring to use this form can have its own papers printed or can obtain copies from the A. F. A. as long as the stock now on hand lasts.

INDENTURE FOR MACHINERY MOLDERS' APPRENTICE.

THIS AGREEMENT, made and entered into this.............day of..... ....A. D. 19..., between.. and ...., doing business under the firm name of.. (or ...., a corporation organized under the laws of the state of...............) of the city of................. county of.....................and state of...................., part of the first part, and ...., a minor, and ...., his father (or his mother or guardian), parties of the second part.

This Indenture, Witnesseth, that the said party of the first part, agrees to take.... ...., a minor, the first named party of the second part, into ....employ and service, for the period of four years from the date hereof, for the purpose of teaching the trade of iron molder to the said.................. ...., minor, as carried on in...........works, in the manner hereinafter specified.

And the said..., minor, the first named party of the second part, covenants and agrees that he will faithfully, honestly and industriously work and serve for said period in such capacity as the foreman may from time to time direct, and that he will obey all rules and regulations in vogue in said works, and will not absent himself from the service of the said party of the first part without leave, unless in case of sickness, and further covenants and agrees to abstain from the use of intoxicating liquors during the said term of apprenticeship.

The said..., minor, further agrees and covenants that he will faithfully perform the work assigned him, which is as follows, but which may be deviated from as long as it does not impair the apprentice's opportunity to learn the trade thoroughly:

Nine months of the first year shall be devoted to making cores and taking care of core boxes, patterns, etc., and three months in taking care of cupola and ladles. Second year at light molding of various kinds and assisting in the care of patterns and helping molders, as occasion may require. Third year to be advanced to a heavier and more difficult class of work as fast as he may prove himself capable. Fourth year to be spent on the best class of work in the shop, whether made in dry or green sand.

The said.., minor, agrees to make up all time lost by him, whether by sickness or absence, each year before he commences on the following year.

The said party of the first part covenants and agrees to teach, or cause said apprentice to be taught or instructed in the trade, which he is apprenticed to learn.

The said party of the first part further agrees to pay unto the said..... ...., minor, for services rendered while learning his trade, for the first year,............ dollars per week; for second year,............dollars per week; for the third year,............dollars per week; and for the fourth year,............dollars per week, and an additional bonus of ten dollars at the end of the first year, twenty dollars at the end of the second year, thirty dollars at the end of the third year and forty dollars at the end of the fourth year of his apprenticeship, it being understood that the payment of these bonuses is optional on the part of the party of the first part, and shall only be paid when the first party is satisfied that the apprentice has faithfully performed all requirements.

If the said.., minor, shall work an additional year on loam work, the party of the first part shall pay unto him the sum of ....dollars per week, and a bonus of fifty dollars at the end of the said additional year on the conditions named above for the previous years.

The said.., father (or mother or guardian) of said minor, covenants and agrees that the said........................... ...., minor, shall faithfully perform and observe all of the covenants and stipulations which he has herein covenanted and agreed to do.

In Witness Whereof, the said parties have hereunto affixed their hands and seals the day and year first above written.

.... SEAL

.... SEAL

.... SEAL

INDENTURE FOR AGRICULTURAL AND STOVE MOLDERS' APPRENTICE.

THIS AGREEMENT, made and entered into this..............day of...... .... A. D. 19...., between.. and ...., doing business under the firm name of .... (or ...., a corporation organized under the laws of the state of................) of the city of................ county of........................and state of................., part of the first part,

and ...., a minor, and ...., his father (or his mother or guardian), parties of the second part.

This Indenture, Witnesseth, that the said party of the first part, agrees to take.... ...., a minor, the first named party of the second part, into ....employ and service, for the period of three years from the date hereof, for the purpose of teaching the trade of iron molder to the said.................... ...., minor, as carried on in...........works, in the manner hereinafter specified.

And the said..., minor, the first named party of the second part, covenants and agrees that he will faithfully, honestly and industriously work and serve for said period in such capacity as the foreman may from time to time direct, and that he will obey all rules and regulations in vogue in said works, and will not absent himself from the service of the said party of the first part without leave, unless in case of sickness, and further covenants and agrees to abstain from the use of intoxicating liquors during the said term of apprenticeship.

The said..., minor, further agrees and covenants that he will faithfully perform the work assigned him, which is as follows, but which may be deviated from as long as it does not impair the apprentice's opportunity to learn the trade thoroughly:

First six months, day work, to be spent in taking care of patterns and core boxes. Second six months in becoming acquainted with the care of cupolas, ladles and flasks, so as to become familiar with their use before starting to mold. Second year to start at the more simple class of work, and the more difficult pieces of work to be given him as fast as he proves himself competent. Third year to be spent on the most difficult class of work.

The said.., minor, agrees to make up all time lost by him, whether by sickness or absence, each year before he commences on the following year.

The said party of the first part covenants and agrees to teach, or cause said apprentice to be taught or instructed in the trade, which he is apprenticed to learn.

The said party of the first part further agrees to pay unto the said................ ...., minor, for services rendered while learning his trade, for the first year,..........dollars per week, day work; second year, board prices less.........per cent. piece work; third year, board prices, less.........per cent. piece work; and a bonus of $10 for extra efficiency at the end of the second year, and $20 at the end of the apprenticeship; it being understood that the payment of these bonuses is optional with the party of the first part, and shall only be paid when the first party is satisfied that the party of the second part has faithfully performed all requirements.

The said..., father (or mother or guardian) of said minor, covenants and agrees that the said.......................... ...., minor, shall faithfully perform and observe all of the covenants and stipulations which he has herein covenanted and agreed to do.

In Witness Whereof, the said parties have hereunto affixed their hands and seals the day and year first above written.

.... : SEAL :

.... : SEAL :

.... : SEAL :

INDENTURE FOR BENCH AND BRASS MOLDERS' APPRENTICE.

THIS AGREEMENT, made and entered into this............day of...... ....A. D. 19...., between.. and ...., doing business under the firm name of .... (or ...., a corporation organized under the laws of the state of...............) of the city of................ county of......................and state of................, part of the first part, and ...., a minor, and ...., his father (or his mother or guardian), parties of the second part.

This Indenture, Witnesseth, that the said party of the first part, agrees to take.... ...., a minor, the first named party of the second part, into ....employ and service, for the period of two years from the date hereof, for the purpose of teaching the trade of molder to the said...................... ...., minor, as carried on in...........works, in the manner hereinafter specified.

And the said.., minor, the first named party of the second part, covenants and agrees that he will faithfully, honestly and industriously work and serve for said period in such capacity as the foreman may from time to time direct, and that he will obey all rules and regulations in vogue in said works, and will not absent himself from the service of the said party of the first part without leave, unless in case of sickness, and further covenants and agrees to abstain from the use of intoxicating liquors during the said term of apprenticeship.

The said.., minor, further agrees and covenants that he will faithfully perform the work assigned him, which is as follows, but which may be deviated from as long as it does not impair the apprentice's opportunity to learn the trade thoroughly:

The first six months to be spent in taking care of cupola and ladles, and working at the core bench, so as to become familiar with his surroundings. Balance of apprenticeship to be devoted to molding entirely, and to be given change of work and a better class of it as fast as he becomes proficient.

. The said.., minor, agrees to make up all time lost by him, whether by sickness or absence, each year before he commences on the following year.

The said party of the first part, covenants and agrees to teach, or cause said apprentice to be taught or instructed in the trade, which he is apprenticed to learn.

The said party of the first part further agrees to pay unto the said................ ...., minor, for services rendered while learning his trade, for the first year,............dollars per week, second year,............per week if day work prevails. Where piece work is the rule,............per week for the first six months; board prices less............per cent. for second six months; prices less............per cent. for the balance of the term, and a bonus of ten dollars at the end of the first year and twenty dollars at the end of the second year shall be added to above; it being understood that the payment of these bonuses is optional with the party of the first part, and shall only be paid when the first party is satisfied that the party of the second part has faithfully performed all requirements.

The said..., father (or mother or guardian) of said minor, covenants and agrees that the said.......................... ...., minor, shall faithfully perform and observe all of the covenants and stipulations which he has herein covenanted and agreed to do.

In Witness Whereof, the said parties have hereunto affixed their hands and seals the day and year first above written.

.... : SEAL :

.... : SEAL :

.... : SEAL :

CUPOLA FAN PRACTICE.

W. H. CARRIER, BUFFALO, N. Y.

The object of this paper is to give reliable data relative to the operation of centrifugal blowers for cupola service, including:

1. The air supply required per pound of coke used and per ton of iron produced.
2. The relation of pressure, size of cupola and speed of melting.
3. The horsepower required for various sizes of cupolas at different pressures, corresponding to different ratios of melting.
4. The relation of speed, pressure and capacity of centrifugal cupola blowers.
5. The effect of piping resistance upon the pressure and horsepower.

Considerable time has recently been spent in securing new data and many previous tests have been re-conducted, in view of a more accurate determination.

Air Supply.

The air required per ton of iron melted has been variously given from 30,000 to 33,000 cubic feet. As it is almost impossible to measure the air directly, it is necessary to resort to indirect methods of chemical analysis of the escaping gases. By analyzing a sufficient number of samples, the amount of air used in the combustion of the coke can be determined with considerable exactness. This also serves to show the nature of the gases produced. In Table I are given the results of several analyses.

Nos. 1 to 4 are from a cupola, 44 inches in diameter inside lining, operated by Buffalo steel pressure blowers at 14 ounces pressure. Nos. 5 to 10 are from a 60-inch Whiting cupola operated at 16½ ounces pressure by a positive blower. Nos. 11 to 14 are from the center blast cupola at the plant of Thomas D. West Foundry Co. This cupola is of Whiting make, measures 74 inches in diameter inside lining, and was operated by a No. 12 Buffalo blower at 9 ounces.

TABLE I

Sample	Pressure	CO_2%	CO%	O%	N%	Air per lb. carbon	Air per lb. coke	B. T. U. per lb. of carbon
1	14 oz.	11.0	10.	0.6	78.4	9.15 lb.	8.1 lb.	8,530
2	14 "	11.6	10.5	2.1	75.8	9.95 "	8.8 "	8,540
3	14 "	13.4	10.4	0.3	85.9	9.3 "	8.2 "	8,800
4	14 "	11.0	14.3	0.5	74.2	8.83 "	7.8 "	7,750
5	16½ "	10.5	10.4	0.8	......	...... "	....	....
6	16½ "	10.5	10.4	.8	78.3	9.15 "	8.24 "	9,420
7	16½ "	12.3	10.7	.9	71.	9.34 "	8.4 "	9,300
8	16½ "	12.4	10.0	.3	76.3	9.07 "	8.16 "	9,960
9	16½ "	11.2	11.9	.4	76.5	8.4 "	7.55 "	9,200
10	16½ "	12.	15.0	1.0	72.	8.57 "	7.7 "	8,850
					Aver. =	8.9 "	8.00 "	9,466
Thomas D. West Foundry Co.								
11	9 "	15.	8.8	.4	75.8	9.5 "	8.55 "	10,700
12	9 "	12.9	10.5	.4	80.2	8.85 "	7.96 "	10,500
13	9 "	17.5	6.7	.1	75.7	9.87 "	8.89 "	11,650
14	9 "	9.3	12.2	.4	78.1	8.7 "	7.83 "	8,725
					Aver. =	9.23 "	8.31 "	10.394

It will be noted that with an average of about 9 pounds of air required per pound of carbon, and with coke containing an average of 90 percent carbon, this will be 8.1 pounds of air per pound of coke. It will also be noted that in the majority of the samples, only about 50 percent of the carbon is burned to carbon dioxide; the remaining portion is burned to carbon monoxide, and liberates only one-third of its total heating value. One pound of carbon burned to carbon dioxide requires prac-

tically 12 pounds of air for combustion; the same burned to carbon monoxide requires only 6 pounds of air. In the first process 14,450 heat units are liberated, while in the second process only 4,400. From this it will be seen that in the present cupola practice less air is required than is necessary for perfect combustion; and only about two-thirds of the total heating value of the fuel is utilized; the remaining one-third escaping in the unburned carbon monoxide gases. The deeper and more intense the fire, the greater seems to be the percentage of carbon monoxide gas produced. In blast furnace practice this gas is present in quantities sufficient to make the gases highly valuable as fuel, either in the production of steam or for use in gas engines. While this discussion is somewhat foreign to the general purpose of this paper, it may be remarked that there is an opportunity for considerable saving in fuel and a consequent increase in the melting ratio by devising some means whereby a more perfect combustion may be secured. The above test so far as conducted, would indicate that the use of the center blast tuyere, first proposed and tried by Mr. Thomas D. West, is a step in the right direction. The samples of gases taken from this cupola, except the last, show a much more perfect combustion than the ordinary side blast cupola.

From the above consideration it appears that the amount of air required per ton of iron depends upon and varies with the melting ratio. The weights and volumes of air given in Table 2 are required per ton of iron for different melting ratios:

TABLE II

Melting Ratio	By Analysis		Perfect Combustion Volume of Air Cu. Ft.
	Weight of Air Lbs.	Volume of Air Cu. Ft.	
7	2320	31,000	41,400
8	2020	27,000	36,000
9	1800	24,000	32,000
10	1620	21,600	28,000
11	1470	19,500	26,200
12	1350	18,000	24,000

The above volumes of air are estimated on an average temperature of 70 degrees. Coke is taken as 90 percent carbon.

Speed of Melting.

The pressure required to give a stated melting capacity with a given sized cupola cannot be stated absolutely with any degree of exactness. This depends, first, upon the melting ratio; second, upon the method of charging; and, third, upon the nature of the coke and iron used. In general, soft coke requires less pressure than hard coke, but does not give as good results. The speed of melting is decreased by the presence of large quantities of scrap or steel in the charge. However, if we take a standard method of charging, comprising a definite ratio of coke to iron and a definite percentage of scrap of uniform size, the variation in speed of melting which will be produced by different pressures follows quite exact laws. Taking a standard charge, the results given in Table 3 will be obtained from a 44-inch cupola, when operated at various speeds.

TABLE III

Pressure	Speed of Fan		Air per Min.	Estimated Melt. Capacity	Horse Power
	R. P. M.	Peripheral Ft. per Min.			
10 oz.	2151	16,193	3,100	6.0 tons	16
11 "	2254	16,966	3,250	6.4 "	18
12 "	2352	17,702	3,400	6.7 "	21
13 "	2450	18,406	3,540	6.9 "	23
14 "	2535	19,081	3,670	7.2 "	26
15 "	2620	19,730	3,800	7.5 "	29
16 "	2705	20 358	3,920	7.8 "	32

From the above it will be seen that the resistance to the air offered by the cupola follows the general laws of fluid friction, that is to say, the amount of air forced through the cupola will vary as the square root of the pressure. For example: If we double the amount of air forced through the cupola, then the pressure will be increased 2^2 or four times, and if the pressure is increased 9 times, $\sqrt{9}$, or three times the amount of air will be forced through. Since the speed of melting with a fixed melting ratio must necessarily be proportional to the amount of air supplied to the cupola, we will have the speed of melting varying as the square root of the pressure.

The melting capacity of a cupola with a given pressure depends upon its size and is nearly proportional to the area of the cross section; hence to the square of the diameter inside the lining. This will not hold exactly with the ordinary side blast tuyere, as somewhat larger pressure is required with the large sizes of cupolas to force the air to the center of the charge. As a result of a number of tests the following formula is determined for the average speed of melting:

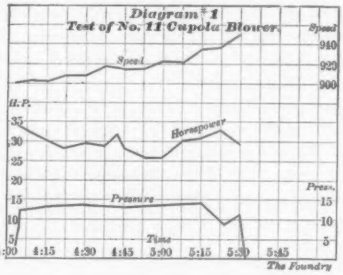
$W = 2D^2\sqrt{p}$;

W = the weight of iron in pounds per hour;

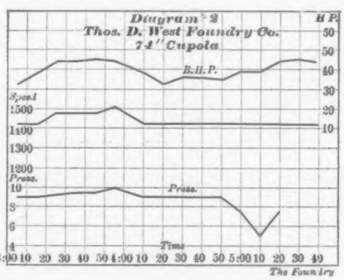
D = the diameter of the cupola inside lining, in inches;

p = pressure at the cupola in ounces per square inch.

This formula holds with a considerable degree of exactness for melting ratios of 10 to 1,



with good quality of hard coke, and for charges containing only a small amount of scrap. Variations in these conditions will of course



vary the results. The air per minute required for various sizes of cupolas may be given by the formula:

$$C = \frac{D^2 \times \sqrt{p}}{2}$$

where C is the cubic feet of air per minute required;

D is the diameter of cupola inside lining in inches;

p is the pressure in ounces per square inch.

This is a safe factor for ordinary use and gives an allowance of about 10 percent for leakage, etc. Below are given several tests which show the results obtained under different conditions. Diagrams 1, 2 and 3 show graphically the variations in pressure and horsepower throughout the heat.

CUPOLA TEST. MAY 21, 1904

Diameter of Cupola	60 in.
Duration of Heat	2 hrs. 50 min.
Average Pressure	15.5
Lbs. Coke Bed	2600 lbs.
Lbs. Coke Total	9000 lbs.
Lbs. Iron	70000 lbs.
Melting Ratio	8 to 1
Coke per Hr.	3180 lbs.
Iron per Hr. (Actual)	24700 lbs.
Iron per Hr. (Formula)	28350 lbs.
Air per lb. Coke	8 lb.
Air per Min. (Actual)	5680 lbs.
Air per Min. (Formula)	7088 lbs.

CUPOLA TEST. MAY 23, 1904

Diameter of Cupola	60 in.
Duration of Heat	2 hrs. 14 min.
Average Pressure	16.18
Lbs. Coke Bed	2600 lbs.
Lbs. Coke Total	8400 lbs.
Lbs. Iron	66000 lbs.
Melting Ratio	8 to 1
Coke per Hr.	3760 lbs.
Iron per Hr. (Actual)	29500 lbs.
Iron per Hr. [Formula]	28950 lbs.
Air per lb. Coke	8 lbs.
Air per Min. (Actual)	6673 lbs.
Air per Min. (Formula)	7238 lbs.

CUPOLA TEST. MAY 31, 1904

Diameter of Cupola	47 in.
Duration of Heat	3 hrs. 9 min.
Average Pressure	17.5
Lbs. Coke Bed	1600 lbs.
Lbs. Coke Total	5600 lbs.
Lbs. Iron	53000 lbs.
Melting Ratio	9.6 to 1
Coke per Hr.	1780 lbs.
Iron per Hr. (Actual)	16800 lbs.
Iron per Hr. (Formula)	18400 lbs.
Air per lb. Coke	8 lbs.
Air per Min. (Actual)	3560 @ 32° = 3950 @ 72°
Air per Min. (Formula)	4600 lbs.

BUFFALO FORGE COMPANY FOUNDRY

Diameter of Cupola	44 in.
Duration of Heat	82 Min. effect. Run 1½ hrs.
Average Pressure	16.43
Lbs. Coke. Total	2500 lbs.
Lbs. Iron	20000 lbs.
Melting Ratio	8 to 1
Coke per Hr.	1830 lbs.
Iron per Hr. (Actual)	14600 lbs.
Iron per Hr. (Formula)	15700 lbs.
Horse Power (Actual)	32
Horse Power (Formula)	33 6
Air per lb. Coke	8.22 lbs.

BUFFALO FORGE COMPANY. JUNE 6, 1904

Diameter of Cupola	44 in.
Duration of Heat	1 hr. 29 min.
Average Pressure	12.67 oz.
Lbs. Coke. (Total)	2500 lbs.
Lbs. Iron	20000 lbs.
Melting Ratio	8 to 1
Coke per Hr.	1686 lbs.
Iron per Hr. (Actual)	13487 lbs.
Iron per Hr. (Formula)	13823
Air per lb. Coke	8 lbs.
Horse Power (Actual)	24.
Horse Power (Formula)	23.13

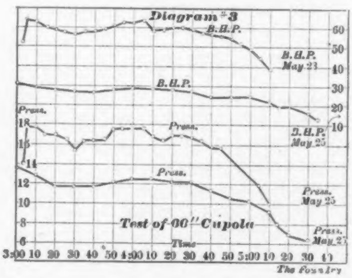
THOS. D. WEST FOUNDRY COMPANY, MAY 31, 1904

No. 12 Buffalo Blower	
Diameter of Cupola	74 in.
Duration of Heat	2 hrs. 37 min.
Average Pressure	8.68
Lbs. Coke Bed	2250 lbs.
Lbs. Coke Total	6750 lbs.
	1200 lbs. left over
	5550 lbs. used
Lbs. Iron	68000 lbs.
Melting Ratio	10.08 to 1 for all coke charged or 12.2 to 1 for coke used.
Coke per Hr.	2120 lbs.
Iron per Hr. (Actual)	26000 lbs.
Iron per Hr. (Formula)	32200 lbs.
Air per lb. coke	8.31 lbs.
Horse Power (Actual)	39.7 = B. H. P.
Horse Power (Formula)	36.3

The above test was made under very unfavorable conditions. In the first place, the heat was exceedingly small for the size of the cupola. Second, the iron consisted largely of large pieces of scrap which had accumulated for some time, many pieces being of such size as to require two men to lift them. This latter

condition was very unfavorable to the speed of melting. It will be noted, however, that the melting ratio was excellent. Taking into account the entire amount of coke, this is about 10 to 1; but making a deduction for the amount of coke which remained unburned at the end of the heat, the actual ratio of melting was 12.2 to 1. This melting ratio is surprisingly high considering the quality of coke used, which was unusually poor.

A very greatly increased melting ratio, however, should be expected from this type of center tuyere cupola, as the chemical analysis of the gases shows that the combustion is much more perfect than with the ordinary type of side blast cupola tested. It will be remem-

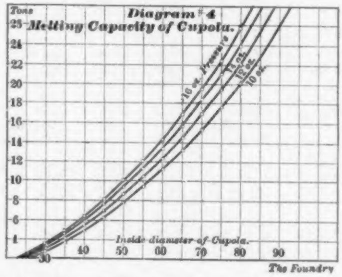


bered that ordinarily only about ⅔ of the total heat of the coke is used. If we neglect the last analysis, you will see that with this cupola over ¾ of the total heat of the coke was utilized.

Horse Power Required to Operate Cupola.

It is usually considered that a certain sized fan, operating at a certain pressure, will require a certain horsepower. This is the usual method of rating given by makers. This rating holds very well when the fans are delivering the amount of air specified at the given pressures, but there is considerable fallacy in using this as the correct horsepower, when applied to cupolas in ordinary practice, since the amount of air which the blower will handle is limited by the size of the cupola; and the horsepower required to operate the fan, as will be shown later, is dependent upon the amount of air which it is allowed to handle.

Each cubic foot of air per minute moved against a pressure of one ounce per square inch, or 9 pounds per square foot, represents the expenditure of .000272 horsepower i. e., with perfect efficiency, 37,000 cubic feet of air per minute moved against one ounce pressure, will require one horsepower. A well constructed fan will give a maximum efficiency of about 60 percent, therefore we will have .00045 horsepower per cubic foot of air per minute per ounce pressure.



The horsepower required for any sized cupola at any pressure, is given by the formula:

$$\text{H. P.} = \frac{D^2\sqrt{p^3}}{3800}$$

D = the diameter of cupola inside of lining in inches; p = the pressure at the cupola in ounces per square inch.

Table IV shows the melting capacity in tons, air per minute required, and horsepower to drive the fan for various sizes of cupolas, and for pressures from 10 to 16 ounces. This horsepower is the actual break horsepower. The pressures given are the actual pressures obtained at the cupola. This table is reliable, and if the fan is provided with the horsepower of motor specified and the cupola is properly managed, no trouble will be experienced from overloading. More power is required for a short time at the beginning and at the end of the heat, due to the decreased resistance at these times, but the duration is so short as to prevent undue heating of the motor. If the fan delivers air too freely at these times, the blast gates should be used to prevent overload.

TABLE NO. IV

Cupola Capacities

Dia. Cupola		Static Pressure of Cupola in oz. per sq. inch			
		10 oz.	12 oz.	14 oz.	16 oz.
30 in.	Cap.	5690	6230	6730	7200
	A. P. M.	1423	1568	1688	1800
	H. P.	7.4	9.7	12.3	15.0
35 in.	Cap.	7740	8480	9170	9800
	A. P. M.	1935	2120	2293	2450
	H. P.	10.0	13.2	16.7	20.4
40 in.	Cap.	10120	11080	11970	12800
	A. P. M.	2530	2770	2993	3200
	H. P.	13.2	17.3	21.8	26.6

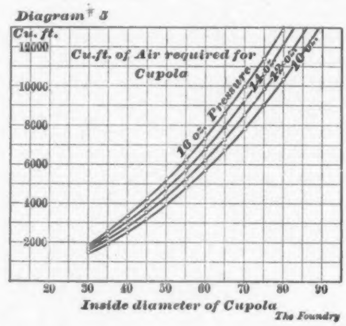
Cupola Capacities—Continued.

45 in.	Cap.	12810	14030	15150	16200
	A. P. M.	3203	3508	3788	4050
	H. P.	16.7	21.9	27.6	33.7
50 in.	Cap.	15810	17320	18700	20000
	A. P. M.	3953	4330	4675	5000
	H. P.	20.6	27.0	34.0	41.6
55 in.	Cap.	19130	20960	22640	24200
	A, P. M.	4783	5240	5660	6050
	H. P.	24.9	32.7	41.2	50.3
60 in.	Cap.	22770	24940	26940	28800
	A. P. M.	5693	6235	6735	7200
	H. P.	29.6	38.9	49.0	59.9
65 in.	Cap.	26730	29270	31620	33800
	A. P. M.	6683	7318	7905	8450
	H. P.	34.8	45 7	57.5	70.3
70 in.	Cap.	30990	33950	36670	39200
	A. P. M.	7748	8488	9168	9800
	H. P.	40.3	52.9	66.7	81.5
75 in.	Cap.	35590	38970	42090	45000
	A. P. M.	8895	9743	10523	11250
	H. P.	46.3	60.8	76.6	93.6
80 in.	Cap.	40480	44340	47890	51200
	A. P. M.	10120	11085	11973	12800
	H. P.	52.6	69.2	87.2	106.5

Diagrams 4, 5 and 6 show graphically the results given in table IV, and are very convenient for reference for sizes of cupolas and for pressures between those given in table.

Performance of Centrifugal Blower.

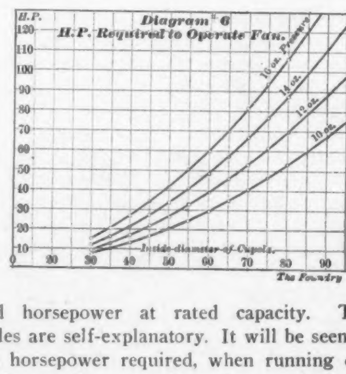
The statement has also been made that the air delivery and horsepower of centrifugal blowers at a given pressure, depends upon the size of the cupola to which it is applied. In this respect the centrifugal blower varies greatly from the positive pressure blower. With a positive pressure blower, as the resistance is increased, either by increasing the speed of the blower, or applying it to a smaller cupola, the pressure and horsepower are both increased in proportion. In the centrifugal blower, the effect upon the horsepower is reversed. With the increase of resistance the pressure is increased as in the positive blower, but the capacity and horsepower are both decreased. If the resistance against which the centrifugal blower is working is decreased, as by putting on a lighter charge, or applying to a larger size cupola, the pressure is decreased to a certain extent, and the capacity and horsepower are increased. In this respect, the centrifugal blower offers some advantages over the positive blowers. The rotary blower, while positive in action, is limited in capacity and can not adjust itself to the variations in demand for air, nor can its capacity and pressure be readily controlled by the operation of a blast gate, as with a centrifugal blower. The flexibility of operation secured with the centrifugal fan may be compared to the action of a spring. Its pressure increases in a certain measure with the increase of resistance; likewise decreases with the decrease of resistance; the volume supplied varies with the conditions of pressure,



and at any time all of the air is supplied which the condition of the cupola will admit. This flexibility often makes the melting capacity of the cupola with a fan blower considerably greater than with a positive blower, owing to the fact that an increased quantity of air can be supplied when required.

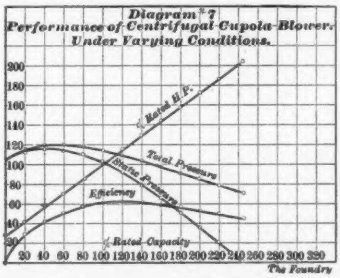
Another advantage of the centrifugal blower is that the same size can be applied to several sizes of cupolas, without altering the speed, and without greatly affecting the efficiency of the blower.

As a basis for comparison of the operation of a centrifugal blower under various conditions, table V gives the pressures produced and the horsepower required for a No. 11 steel pressure blower, operating at a constant speed of 1,960 revolutions, and handling various quantities of air from zero to maximum capacity at free delivery. Table VI gives the same results on the basis of capacity, pressure



and horsepower at rated capacity. These tables are self-explanatory. It will be seen that the horsepower required, when running open, is about twice as much as that required when

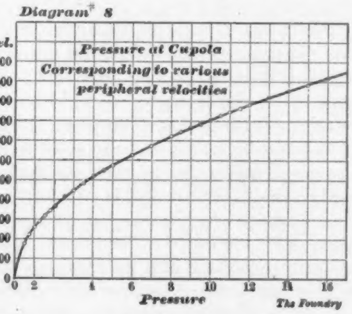
operating at rated capacity, and that when running closed it is only 28 percent as much as that required at rated capacity, or 14 percent of the horsepower required at free delivery. It will also be seen that the increase in horsepower is proportional to the increase in capacity. The pressure increases from free delivery up to about 60 percent of the rated



capacity; from 60 percent of the rated capacity to the closed outlet, the pressure again decreases, which shows that the maximum pressure is secured at 60 percent rated capacity. The rated capacity of the blower is based upon the capacity and pressure at which it will operate most economically. This is shown in the column marked Percent Efficiency; these results are also shown graphically in diagram 7.

As has been shown, the capacity under any condition is proportional to the speed of the fan, and the pressure is proportional to the square of the speed. From this it follows that the horsepower required to drive the fan will vary as the cube of the speed; for instance: suppose that a No. 11 cupola blower, operating at 1,800 r. p. m. requires 25 horsepower, when attached to a certain cupola. Now if the

Diagram 8



speed is increased from 1,800 to 1,980, or 10 percent, then the horsepower will be increased to $1.10 \times 1.10 \times 1.10 = 1.33$ times, or an increase of 33 percent in horsepower, which will make the horsepower at 1,980 revolutions, 33.3. Also, if a No. 11 blower gives 10 ounces pressure at 1,800 r. p. m. when applied to a certain

TABLE V

Performance of No. 11 Centrifugal Cupola Blower at 1960 R. P. M.

Capacity	Pressure		Horse-Power
	Static	Total	
0	12.35	12.35	12.25
392	13.55	13.7	18.38
735	13.9	14.28	24.93
1178	13.8	14.4	31.45
1570	13.2	14.28	37.6
1960	12.35	13.8	43.73
2355	11.04	13.08	50.7
2748	9.6	12.35	56.8
3140	7.91	11.64	63.
3530	6.12	10.91	69.5
3920	4.32	10.2	75.6
2320	2.38	9.475	81.75
4790*	0.	8.7	88.3

*Free Delivery.

cupola, it will give $1.10 \times 1.10 = 1.21$ times that pressure for an increase of 10 percent in speed, that is, at the speed of 1,980, the pressure will be 12.1 ounces.

Table VII and diagram 8 show the various peripheral speeds of the blast wheel, required for different pressures at the cupola. For ex-

TABLE VI

Performance of Centrifugal Cupola Blower Under Varying Conditions

Per cent. Rated Capacity	Per cent. Rated Pressure		Per cent. Rated H. P.	Per cent. Efficiency
	Static	Total		
0	103	103	28	0.
20	113	114	42	27.6
40	116	119	57	40.8
60	115	120	72	50.4
80	110	119	86	56.4
100	103	115	100	60.
120	92	109	116	61.8
140	80	103	130	61.7
160	66	97	144	58.8
180	51	91	159	56.4
200	36	85	173	52.8
220	19	79	187	49.2
244*	0	72½	202	45.0

*Free Delivery.

ample: supposing it is required to find the speed of a blower 34½ in. in diameter; to give 14 ounces pressure at the cupola. Since the diameter is 34½ in., the periphery of the wheel will be $3.14 \times 34\frac{1}{2}$ in. $\div 12 = 9.92$ feet. From the table we find that the peripheral speed required is 19,081 feet per minute. Revolutions per minute of the fan will therefore be $19{,}081 \div 9.02 = 2{,}113$ r. p. m.

Effect of Piping Resistance.

The piping connections from blower to cupola affect considerably the results secured. With a short straight pipe the pressure at the cupola will be practically the same as at the fan outlet. If, however, the connection is long and has a number of sharp bends, the pressure

may be reduced several ounces. If the speed of the fan is not increased, the horsepower will be decreased by this resistance, but the melting capacity of the cupola will also be decreased. The pressure at the fan outlet will be slightly increased by the extra resistance offered by the fan. If, however, the fan is speeded up to secure the desired pressure at the cupola, then a considerably increased horsepower will be required to overcome the extra resistance of the piping.

TABLE VII

Peripheral Velocities Required for Various Pressures at Cupola

Pressure	Peripheral Velocity
8 oz.	14514
9 "	15378
10 "	16193
11 "	16966
12 "	17702
13 "	18406
14 "	19081
15 "	19731
16 "	20358

Summary.

The following main points in fan cupola-practice should be emphasized:

First.—The horsepower required to operate a cupola at any stated pressure is, to a certain extent, independent of the size of the blower, so long as it has sufficient capacity to supply the required amount of air.

Second.—The melting capacity of the cupola under standard conditions, varies with the pressure according to fixed laws.

Third.—More horsepower is required per ton of iron melted, at the higher pressures than at the lower pressures.

Fourth.—At a fixed speed, the greatest horsepower is taken when the blower is running wide open, or at free delivery; the least horsepower is taken when the outlet is closed. The increase in horsepower is proportional to the increase in air delivery.

Fifth.—The piping resistance decreases the air delivery and decreases the horsepower at a fixed speed, but increases the horsepower when the fan is speeded up to give the same pressure at the cupola.

Sixth.—The centrifugal blower presents some advantages over the positive blower, from the fact that better results can be secured at lower pressures, but there is a greater uniformity of blast pressure, and it offers a flexibility in regulation. With the exception of the belting, there is but little wear or deterioration; it will give as high efficiency after running twenty years, as when first installed. On the other hand, the positive blower, owing to the friction of the contact surfaces, wears and deteriorates rapidly, and its effect while high at the beginning, decreases rapidly, owing to the leakage caused by the wearing away of the contact parts.

FAN BLOWERS FOR CUPOLA WORK.

G.-WM. SANGSTER, BOSTON, MASS.

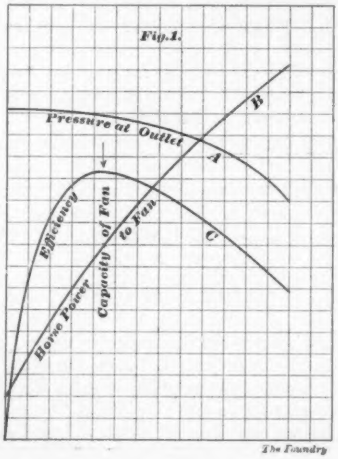
A recent paper by Thos. D. West on Fan Power for the Cupola has suggested to the writer that a few notes on the principles of fan blowers might be of interest to foundrymen.

We may consider the fan, piping and cupola as forming part of what is called by Reuleaux a "Ring System" in which the atmosphere itself is the connecting link. The air is taken in at the inlet of the fan, expelled through the outlet, into the piping, thence to the cupola, up through the burden to the atmosphere and back again to the fan inlet. The atmosphere may be considered a reservoir out of which the air is taken at one opening and returned at another.

The important points in this system are the fan and the cupola burden. In the former the air is raised from atmospheric pressure to that required by the cupola and in the latter this excess of pressure is lost in passing up through the charges. Obstructions, such as sharp bends, long piping or pipes of small diameter, etc., result in a loss of pressure and therefore of efficiency. The ideal arrangement calls for a fan as close to the cupola as possible with short, straight piping of large diameter, such bends as are absolutely necessary to have long easy curves. The inside radius of an elbow should never be less than the diameter of the pipe.

A centrifugal fan will maintain a practically constant pressure while delivering air through an opening varying from zero up to an area called the "capacity of the fan." Beyond this area the pressure falls away, although the total amount of air delivered as well as the power required by the fan are both increased. This is illustrated by the curves in Fig. 1 in which the pressure at the opening is indicated by the curve A, the power required by the fan by curve B and the efficiency by C. It will be noted that A is practically constant for a considerable variation of opening, that B has its origin above zero owing to the fact that a fan as well as any other machine takes a certain amount of power when running idle and C starts from zero, rapidly reaches the

point of highest efficiency at an area equivalent to the capacity of the fan and then gradually decreases. A fan blower is usually sold



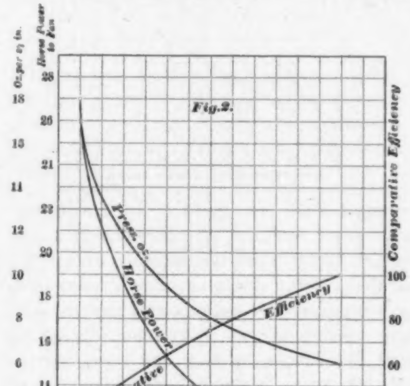
to deliver a certain volume of air at a specified pressure and the horsepower required is estimated for this duty. By an examination of curve A in Fig. 1 we note that the power required to drive a fan at full outlet is about twice that required when working under maximum efficiency, while the pressure falls away 25 to 30 percent and the efficiency drops to about 60 percent of that of the capacity of the fan.

With the older methods of power transmission, the fact that a fan was too small for its work was usually unnoticed; even today the fan user seldom realizes to what an extent his fan may be overloaded. Should the work put upon a blower become excessive there are two ways of correcting the trouble; one by putting in a larger fan, piping, etc., and the other and more usual method of speeding up the fan. The latter is such a simple remedy that the user does it as a matter of course, not realizing to what an extent he is squandering his coal pile.

To show the effect of overloading a blower three fans are selected, each delivering a certain volume of air through an opening at 6 ounces pressure. Two of the fans are too small for the duty and the third is of ample capacity. Fig. 2 shows the horsepowers, pressures at which the fans must be run and their comparative efficiencies. Fan A takes 27 h. p.; B 13½ h. p.; and C but 10 h. p. Estimating the cost of a horsepower per year, for a 10-hour day, at $50, it will cost $850 more per year to run A than C and $175 more to run B than C. This is due to the fact that fan A has to be speeded up to 17 ounces and B to 8 ounces in order that there may be a pressure of 6 ounces at the final outlet. C being of ample capacity is run at the proper speed to generate 6 ounces. Calling the efficiency of fan C under these conditions 100 percent we note that fan B has but 74 percent and C only 37 percent efficiency. The costs of the three fans installed ready to run are approximately A, $180; B, $225, and C, $325. By replacing A by C the original outlay will be repaid in about two months, with a future interest return of over 250 percent on the investment. By replacing B by C the original outlay will be repaid inside of seven months, with a future interest return of over 75 percent. This is on a basis of a 10-hour heat, but as average practice calls for a 2-hour heat, the cost of replacing A by C will be repaid in 10 months with an interest return of 50 percent, and fan B by C in 2½ years with an interest return of 15 percent.

Overloading fans A and B in the manner shown is just as sensible as generating steam in a boiler at 100 pounds pressure and using it in an engine at 40 pounds.

In order that a sufficient amount of air may

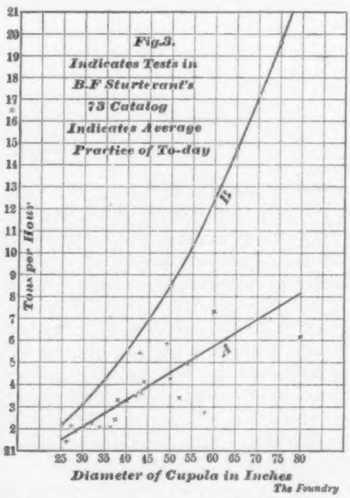


flow through the smaller fans they have to be run at excessive speeds to obtain the necessary pressures and velocities for the air.

Fig. 3 illustrates the extent of progress in the melting rates of today, as compared with that of the early 70s, when Mr. B. F. Sturte-

vant compiled and published his series of tests on cupola practice of that time. These appear to be the first available data of the kind published in this country. It is of interest to note the very low melting rate of that period, especially in the larger sizes, as shown by curve A, and to compare it with the melting practice of today as shown by curve B. This means that the cupola is now harder driven and calls for more air and larger fans.

In order to force a sufficient quantity of air through the cupola greater pressures are required and consequently more horsepower per ton melted per hour. Better results will follow from the use of the still larger blowers. In the example mentioned by Mr. West he is



running his fan at a speed of 15 ounces pressure, but the openings through the cupola burden are larger than the capacity of his fan and the pressure drops to 12 or 13 ounces in the wind box. By putting in a fan of sufficient capacity to run at 13 ounces speed he could save about 10 h. p., or from $300 to $500 per year, depending upon the cost of power. At present he is in the position of using fan B, Fig. 2, for work which ought to be performed by a fan of the capacity corresponding to C.

Mr. West advises the purchase of a motor with a capacity equal to that required by the fan with free outlet. As a purchaser usually objects to first costs, it will take considerable selling ability to convince him that he should put in a motor of two or three times the capacity required for normal conditions. By partially shutting the blast gate at the beginning of a heat and closing it before the bottom is dropped he can prevent an overload and save on first cost. A motor is usually good for an excessive load for a short period and besides is safe-guarded by circuit breaker or fuse.

A generous allowance for the horsepower required by a fan blower in cupola practice may be obtained by the formula:

$$\frac{\text{Tons melted per hour} \times \text{pressure in ounces}}{3}$$

A 66-inch cupola according to Fig. 3 should melt 15 tons per hour. Calling the blast pressure 14 ounces we will require

$$\frac{15 \times 14}{3} = 70 \text{ H. P.}$$

Adding 20 percent for losses in motor, piping, etc., we will require about an 85-h. p. motor. Good cupola practice calls for less power than this, or

$$\frac{\text{Tons melted per hour} \times \text{pressure in ounces}}{4}$$

which will require about 52½ h. p., but the first formula is safer since it allows an ample reserve for emergencies.

In a foundry with which the writer is connected the usual melting rate is from 12½ to 13 tons per hour in a No. 7 Whiting cupola, lined to 60 inches. Blast pressure 12½ to 13 ounces, using a No. 10 Sturtevant blower which is a size larger than recommended by the cupola people; fuel ratio, including bed, about 1 to 8. The average horsepower input to fan is 35 to 40 and to motor 40 to 45. The motor is belted to fan, and power readings are easily taken. The iron requires to be hot as a large proportion of the castings are thin and light. The charges are made up with 40 to 50 percent of scrap and sprues and the balance of pig. The fan is driven by a 60-h. p. motor which is, therefore, not heavily loaded. The blast gate is controlled as already suggested.

Under similar conditions Mr. West should require for his work using a fan of proper capacity, about 45 to 50 h. p. input to the blower and 50 to 55 to the motor.

The salesman to whom Mr. West referred could not have understood the first principles of the fan blower when making the assertion that a fan took more power with a closed outlet. The principle of the fan blower is somewhat similar to that of a gravity system of waterworks supplied by a reservoir. When the flow of water is shut off there is no expenditure of power. The same holds true in

the case of the fan blower, except for the power required to overcome the friction of the machinery and the revolving mass of air. As the area of the opening is increased, the pressure at the same point gradually decreases both in the gravity system and in the fan blower and both are due to loss by friction through the various passages, although in the case of the fan blower there is a further loss of pressure due to the partial vacuum generated in the inlet of the fan. This vacuum is required to provide sufficient velocity for the entering air and increases with the area of the fan outlet.

Summarizing we may note:

1. The horsepower required by a cupola should average the result obtained by multiplying the tons melted per hour by the pressure in ounces and dividing the result by 4.

2. The tons of iron per hour melted in a cupola should average as follows: Square the diameter inside the lining in inches and multiply by .0035.

3. Install a fan of ample capacity so that the pressure in the wind box during a heat equals that at the outlet of the fan, or nearly so, when the blast gate is shut.

4. Use short straight piping of large diameter, and if necessary elbows with long easy curves.

5. Don't overload the fan; a small original investment will soon pay for itself.

6. Doubling the speed of a fan practically doubles the volume of air delivered, at four times the pressure, but it takes *eight times as much power.*

DISCUSSION ON THE CORE QUESTION.

BY J. S. ROBESON, CAMDEN, N. J.

In the two interesting articles by Mr. Fuller and Mr. Neil on the core bench and the coremaker, I find that they both strike the same note in two instances and each in no uncertain manner.

First, as to the lack of attention and consideration given to this branch of the business.

This, to the shame of the trade, is unquestionably true. I would, however, go further than they do and say that because of this lack of interest, this absence of discussion, there exists great ignorance in the core room regarding many details of the work.

This is not so much as to the work turned out, because the individual manual skill displayed is often remarkable, and cores that seem almost impossible in the way of shape and venting are successfully made.

It is most marked, however, when it comes to the question of cost; this, applying both to the labor required on a job (the best and quickest way of turning out any particular core) and to the materials (the sand or sands and the binder).

This is due, in my opinion, to the lack of literature on the subject and to the almost entire absence of an exchange of ideas between foremen, for, however great the knowledge and skill of any one man, it is absurd to suppose that he knows all. It has been proven again and again, in other trades, that discussion and criticism of methods of work lead to the advancement of all the members and not to the particular advantage of any single one.

When this change has been brought about, and it is bound to come in the coremaking trade, one of the first points recognized will be that this work bears a closer relation to the cost per pound of the finished casting than is now realized.

As an example of this, and such conditions are very common, a well-known and otherwise well run foundry had for years been making a core out of a mixture of three sands, costing as follows (the figures used are relatively, not actually, correct):

A.

No. 1, using one-third	$1.75	per ton
" 2, " "	2.20	"
" 3, " "	0.65	"

By a mere accident, and understand that he has been near by for years, the foreman of this shop happened to hear that a foundry in the same town was using a local sand on some similar cores. This led him to order some and, after a test or two, he adopted this mix:

B.

No. 3, using two-thirds..................	$0.65
No. 4, using one-third....................	1.20
Cost per ton of sand......................	0.83

A saving of $0.70 on each ton of core sand used.

The binder has been used on the "A" mix in the proportion of 1 to 22, but this was found to be too much for the "B" mix and it was changed to 1 to 40. Hence another decided saving and with actually better cores, though the first had been plenty good enough.

This "plenty good enough" is the barrier that has prevented many an economy. If cores can be made easily, the castings clean well and there be no trouble from blowing. In far too many cases are the core sand mixture and the binder considered to be perfectly satisfactory and the cost forgotten.

A study of core sands will show several other ways in which they may affect the cost sheet. A free discussion is a great incentive to start workers in a field of this sort.

Second, as to the method of mixing and tempering. While Mr. Fuller and Mr. Neil refer to this for different reasons and as causing different results, yet the same trouble, that of improper mixing and tempering, is what inspired their remarks.

Whether a man be using flour, rosin, molasses or one of the many compounds on the market, he should insist on the most perfect mixture possible—the more evenly distributed the binder is throughout the sand mass the better will be the core.

It is for this reason that a liquid binder (not an oil), that will mix readily with water will produce the best results at the lowest cost. Less work, and especially if the mixed sand mass be allowed to stand for two or three hours or over night, since the liquid flows and seeps through the sand until each grain is evenly coated, will produce a better mixture than with any dry binder.

When Mr. Neil speaks of crushing the sand, I think it is not only the crushing (though I do not wish to underrate the value of this for a moment), but the fact that the binder is mixed with the sand during the crushing that aids so greatly in producing the good results to which he refers.

A very good every day example of this can be seen in the practice of the steel foundries. There a sharp sand is used, having absolutely no self-binding qualities and yet their liquid binder, mixed with the sand in a grinding pan, is added in the proportions of 1 to 60 up to 1 to 80. These proportions are, to put it mildly, not common in iron foundries using a sharp sand.

SUCCESSFUL BRASSFOUNDING.

BY JOHN F. BUCHANAN, SIDNEY, N. S. W.

Foreword.

In responding to the request of your secretary for "a short paper on some foundry topic, brass or iron," I experienced (in addition to the natural trepidation of an ordinary molder who fancies he can use the "peen" to better advantage than the pen), great difficulty in choosing a subject worthy the attention of such a successful body as the American Foundrymen's Association.

Inasmuch as brassfounding can only interest a section of your members, and I am doubtful if my experience can hold even that section from weariness, it is just possible that a change from the didactic to the personal form of address may assist both the hearer and the writer to be more at ease in the fulfillment of their respective duties. As the son of a brassfounder, a foreman with a fair record, and an occasional contributor to the English and American trade journals, I claim your indulgence while I introduce a few sidelights on "Successful Brassfounding."

Introductory.

The title of this paper would seem to call for a double-barreled definition, *viz.*: Why Successful? and What Class of Brassfounding? Success, I take it, is that which we expect in a properly modeled love story—a happy termination; brassfounding is the antithesis of that, for although it is the oldest branch of the metal casting industries (and it had a happy beginning), it has fallen on degenerate days and is seldom encouraged except when the utilitarian art of the iron or steel founder is either unequal to the occasion or unable to harmonize with the general scheme. I question if the *gray* or *malleable* gentleman who prides himself on turning out castings, which unfortunately have consumptive tendencies, has ever given a serious thought to the "thing-of-beauty-and-joy-forever" variety produced by his fellow founder Mr. Alloys, the son of Alchemist.

Legendary.

Just think! The world's history might easily be written in chapters on bronze, the opening numbers of which may be roughly summarized thus:

Chapter I.—Palæolithic man, worn with the worries of the Stone Age and grumbling at the necessity for renewing the cutting edge of his uncouth implements, expressed in the hearing of his grandson a longing for more enduring tools. The boy, eager to acquit himself, after long and adventurous search, brought forth triumphant from a fissure in the Great Rock a nugget which, for want of a better name, was afterwards called *Aurichalcum* (i. e., Golden Copper). And thus originated the first artificer in metals!

Chapter II.—The artificers grew and multiplied, and the harvests being sooner garnered with the improved appliances, they

waxed thoughtful, but no less industrious. Bending their minds to those things most worthy of worship, they adorned the temples, made god-like images and warlike weapons, raised monuments to their heroes and generally behaved themselves in a manner becoming the fortunate scions of the ever memorable and almost everlasting Bronze Age.

Chapter III.—In the Middle Ages, the church being all-powerful and desiring to proclaim the fact for all time, inspired the now skillful bronzefounders to invent some *striking* vessel which would yet speak when her ministers were dead. The bellfounding feats of these patriarchs are beyond us today, and we have evidences in many parts of the world that they were no fool molders anyhow!

Chapter IV.—When the so-called civilization of the Western nations created that lust for Empire, which still threatens to engulf us, those docile workers, now called brassfounders, were requisitioned to produce an engine which would send the superfluous savages occupying the desirable places of the earth, into "Kingdom Come." With characteristic ingenuity befitting such highly developed craftsmen they compounded a metal *able to withstand the shock!* Gun-metal, as you are aware, is used to this day—sometimes successfully. It has a name which is universally admired and for *that* the public pay ungrudgingly the highest price. Some day an enthusiast from the ranks of the "Brassies," with a quicker imagination than I, may be inspired to write up more fully the historical side of Successful Brassfounding. Meanwhile, we must get back to the modern and more practical aspects of the subject.

Practical.

Successful brassfounding is only to be accomplished by (1) specialization of the work, (2) system in the making up of mixtures, and (3) the adoption of all the mechanical and commercial aids which apply to the other branches of foundry practice. Americans do not need to be told to specialize; they are compound specialists already. But I observe that even they have various methods of arriving at the same results, which proves that there is no rigid formula for success in anything. In some quarters successful brassfounding means the art of making a legitimate profit on brass castings; in others it means the art of making castings from copper alloyed with the greatest amount of the cheapest adulterants compatible with certain tests or specifications. Here we have the choice of two straws, either of which may break the (brass) camel's back when carelessly applied.

Retrospect.

Ten years ago I made my debut as a foundry foreman in a large engineering shop in the capital of Scotland, where ornamental brasswork, gas, water, and steam brass fittings, millwright and general engineer's brass castings, locomotive and admiralty castings *were all done on one floor!* That was, and is, a successful brass foundry; but, looking back on my experience there, I am convinced that the work could have been more satisfactorily accomplished, with more comfort to the employees and greater profit to the employers if, instead of carrying on the business with one shop foreman and a leading hand for each class of work, two of the lines had been dropped, so that the others could be developed enough to warrant the appointment of a special foreman for each. Later in my career as a foreman I graduated to a charge in a gray-iron foundry doing general brass castings. In this case the brass furnaces were at one end of the shop and the cupolas were at the other end. The treatment which the metal in that brass foundry received, nearly drove me crazy. Scrap was made recklessly, the spare metal was poured into "pancakes" instead of into clean ingot molds, the crucibles were dumped about like hand-ladles and left in the most convenient place for receiving slops. In less than two days there was an unheaval in that shop and great was the shock thereof! But it took time and many sermons to put it in the way of being what I would term a successful brass foundry.

Splendid Isolation.

Since then I have always held that it is a mistake to carry on combination brass and iron foundries, unless there is some barrier between the two sets of molders; otherwise the sands get mixed, the scraps get mixed, and in many cases the brass end becomes the happy hunting ground for a few incompetents from the other end. You must not infer from this that I deprecate the running of brass and iron foundries con-

jointly; I only wish to insist that iron foundry methods will not do for the brass foundry. The two kinds of castings cannot be made by the same process, or under the same foreman, *with the best results.* The metals and the molds require different treatment and the higher price and more sensitive nature of the alloys demand that keener vigilance and greater skill should be employed to handle them. The brass molder must exercise greater care and neatness in his work because there is less divergence from pattern sizes permissible in his castings; he must be alive to the fact that defects in brass castings are always more unsightly, more difficult to remedy and more costly, than similar defects in iron castings; in green sand work he must avoid fins; and with dry sand castings, "wings" thicker than a trowel blade are a reproach to the ensemble and a menace to his position in the ranks of successful brass molders. Obviously foundrymen have nothing to gain by trying to embrace all the branches. Besides, in arranging a foundry, it is a great deal easier to provide facilities for a definite class of work than to meet the demands of a mixed trade.

On the other hand, just as greater economy can be effected in an iron foundry with a machine shop on the premises, so it is with a brass foundry contiguous to an iron foundry. Core-irons, pigs and tackle of every description can then be had at first cost, and, if heavy brass castings are made, many of the tools can be more fully employed between the two foundries than in one alone. One of the greatest drawbacks in an isolated brass foundry doing heavy castings is the expense of getting out tackle.

Extravagance.

I could direct you to several world-famed marine brass foundries in Glasgow where brass "core-irons," brass building rings, brass bows for propellers, brass core boxes, box-parts, etc., are in daily use. I fancy I hear someone exclaim, "This is extravagance with a vengeance!" Granted! Yet the saving made by producing the tackle at cost and the economy of time in getting through with the jobs seems to counterbalance the initial expense. At any rate the foundries I refer to are, in every case, successful.

General Brassfounding.

The dividing line between the various branches is not so well marked in brass as in iron foundries. "General Brassfounders" is still a common designation for foundrymen casting in alloys to adopt. Doubtless many are willing to undertake work of a general kind, but if we probe into the actual output, we will find that brass founders are biased in some particular direction. Some prefer to do light or ornamental castings, while others look more to tonnage. However ready they may apear to be to face anything in the shape of brass castings certain lines are always given the precedence. One reason for this is the increasing number of alloys now in demand. Twenty years ago "General Brassfounders" was the correct description of the more successful firms, whereas now we have to distinguish between several kinds of engineer's, plumber's and other dependent brass founders. Shop mixtures have grown from the mnemonic recipes of the secretive foreman of the old school to the inexhaustible tables and memoranda of the twentieth century scientific expert on the subject; but, commercial considerations apart, it is an open question whether the multiplicity of cheap alloys now used, has helped, as much as it has hindered, the progress and prosperity of the brass castings trade.

More Retrospect.

Many a time, and oft, have I been told about the "good old days" when gun-metal was hall-marked and all the other alloys were as true to standard as the coin of the realm—the days when they did not know the use of drugs in the metal trades, or how to disguise or load base metals in the alloys. Nevertheless I am no pessimist. I believe the more ardently we study alloys the more we shall add to the general store of experience and wisdom in the use of them, and the better we shall be able to adapt our business to the needs of our time.

Prophecy.

I also believe the day is not far distant when the metallurgist will do for the brass founder what the chemist has already done for the iron founder—regulate his mixtures, fix new standards, determine the casting temperatures and the best conditions to secure the highest results out of the various combinations of metals and metalloids. It is in this, the subject of mixtures and the

methods of calculating and manipulating them, that we reach the kernel of the question before us. Many good molders and excellent foremen have failed to realize success because of their inability to grasp these most important factors in brass foundry management. They were molders first and mathematicians and metallurgists a very long way after. Lest I should lead someone to think I pose as a scholarly person, I beg to say that I know neither mathematics nor metallurgy as they should be known, but for many years I have been studying the practical difficulties to be met with in brass foundry practice and discussing the problems dear to the heart of the man who takes a genuine interest in his work. No one deplores the limits of secondary education more than I do and I would urge upon any gentleman present who has an earnest man in his employ, to put every incentive in front of that man if he values skill in handicraft.

Mixtures.

But, to return to our mixtures; the percentage plan is now used for stating mixtures in brass as well as in iron foundries. The old-fashioned method of stating brass mixtures in pounds and ounces was always troublesome unless when the original quantities were adhered to. A point of economy which is frequently lost sight of is that the amount of metal required for each heat should receive the most careful calculation. Every pound melted over the actual requirements increases the waste and adds to the cost of production. "Spare" metal is a necessity in every foundry, but the motto in the brass foundry should be, "Be sparing with it."

Like chaplets, patternmaking, and other "necessary evils," it wants looking after. In many of the branches of brassfounding the use of old metals is imperative. Contracts are sometimes let for little more than the price of the new alloy, and unless old metals were of service it would be impossible to carry out the work. This is where the man experienced in the selecting and blending of metals shines. By a judicious examination of the available scrap he is able to make a cheaper, though not necessarily a worse, alloy than the other fellow. In building up mixtures, no brass scrap should be reckoned to contain to exceed 40 percent zinc, and no G. M. scrap should be reckoned below 75 percent copper. Lead and tin in G. M. scrap may be approximated by the fracture, skin and color of a cold sample, while iron, phosphorus and aluminum can not be mistaken in the molten condition of the metal. In figuring a mixture for a brass alloy, if old metals are used, it is customary to make an allowance for volatilization of zinc, say, from .5 to 1.0 percent, according to bulk, but with alloys containing over 8 percent tin, the loss of tin on remelting would be nearer .25 percent. The great secret of good mixing is to avoid "soaking," and adopt uniform grades, marking castings and runners according to grade number and keeping separate bins for each. If much old metal is used in making the lower grades, half worn crucibles should be used, the newer pots being reserved for melting the cleaner metals. All metals should be charged into crucibles in the vertical position to avoid wedging and other dangerous contingencies.

Skimmings and furnace ashes should be ground, washed and melted down by themselves, for mixing with known proportions of other metals. Borings should be classified and used in the first charge of metal to act as a cushion and to assist in the reduction of the solid portions. I have noticed that borings of almost any of the alloys *are more fluid when remelted* than the original mixture. Indeed I have often taken advantage of this peculiarity in running thin castings of large area, also in "burning" thick sections economically.

1. 2. 3.

Chaplets.

Chaplets for finished brass work should be cast from the same composition as the castings. A convenient form of chaplet is the girder shape, shown in section at Fig. 1. These can be cast in long sprays of the various thicknesses and cut off as required. For heavy castings, copper springer, Fig. 2, or stud chaplets, Fig. 3, will be found to give complete satisfaction. Molds should not be poured if the metal is not in perfect condition for casting; it is better to lose the cost of melting than to risk the cost of remolding and machining.

Skin-Drying.

Many small molds for brass are skin-dried previous to being cast. An "industrial railway" from the molding stalls to the drying stove is a great convenience, the molders need not handle the flasks except when making or closing the molds. I have often been struck with the difference in the weight limit of green sand castings in cast iron and in brass. Molds for cast iron are generally made from more porous material than molds for brass; molten iron has a higher temperature than brass, and yet it is possible to make a heavier and cleaner casting in green sand with the former. To get over this difficulty, several large brass foundries on the Clyde skin-dry heavy green sand molds by saturating them with naphtha and setting them alight. When the naphtha has completely burned off, these molds, which may represent castings weighing up to half a ton, are closed and immediately cast. I mention this as a unique example of heavy green sand work suitable for castings of large area and medium depth.

The brass founders cannot afford to despise the mechanical aids to molding; success for them, even more than for others, depends on a proper equipment; their castings must be more accurate, as to weight and dimensions; for the smaller machining allowance given them leaves less margin for inaccuracies. That is why the habit of "bedding in," or the use of "stakes" is not generally practiced in brass foundries. Properly fitted flasks, an orderly casting floor, and a well-furnished cleaning room are business-like signs in an up-to-date brass foundry. Further, your true brass founder likes to see the skin of his castings; he admires the ruddy complexion; he is fond of rich tints and *no trimming*. The scratches of a file or the marks of chisel on a good specimen annoy him as much as the "cats of Kilkenny" in chorus might annoy a nerve specialist.

Pickling.

Cosmetics and condiments are artificial commodities used by humans to counteract blemishes in their physical arrangement—so it is with "pickles" in the brass foundry! The sickly pallor of "leady-cock-metal" fittings, and the hectic flush of acidulated "coppery-steam-metal" parts, proclaim the art of the dyspeptic brassfounder who seeks to make old metals look new. As only a few of the alloys are really improved in appearance by an acid bath, I hold that the advantages of pickling are debatable—much depends on the pickle and the duty of the castings. With good metals pickling is an unnecessary process; with poor mixtures, it is sometimes an unfriendly one; and I make it a rule never to pickle castings intended for hydraulic tests.

Blowing out cores is another practice which is sometimes overdone. Unless with castings of about equal thickness, or with intricate cores, the small advantage gained by being rid of internal dressing could be equalized by closer attention to the core sand and fettling departments, and the castings would be free from cooling strains.

I shall not weary you further with cursory comments on small, debatable matters. This hurriedly written paper, as I said at the beginning, was started with the object of throwing a few side-lights on the subject of successful brassfounding—they may have been only dim, uncertain glimmerings, but brassfounding being a dark subject, the smallest ray may be an illumination in itself. It has been my aim to show (1) that the discovery of bronze opened up the field for metal castings; (2) that no castings have attained to the eminence of the bronze castings; and (3) in order to become successful brassfounders you should honor the traditions of the trade (the chief one being "Take care of the metals; the molds will take care of themselves"), and be imbued with the belief that radium may come and steel may go, but bronze will continue forever.

ECONOMY IN FOUNDRY COST-FINDING.

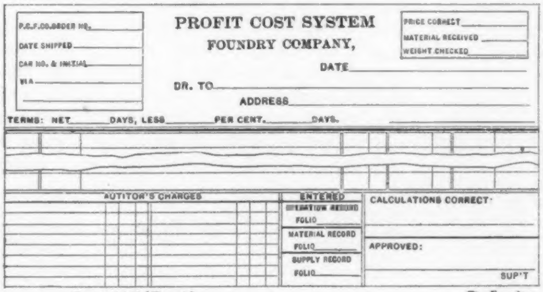
BY JAS. C. LOUGHEY.

When we speak of economy in cost-finding, we do not mean only that which implies the least expenditure. Webster, in defining economy, says: "That management which expends money to advantage and incurs no waste; frugality in the necessary expenditure of money. It differs from parsimony which implies an improper saving of expense." To produce without finding the cost, is "improper saving of expense" and not economy. To find the cost of casting requires expense; to educate our children is also an expense, but who in this age looks upon it as unnecessary. Perhaps

some children may not yield a profit on such expenditures, but that is the fault of the child or the instructor, and not the education. It may be that for some foundrymen cost-finding has not been a profitable investment, but that is the fault of the system or the one who executes it, and not the knowledge of the cost of their castings.

Economy to Know the Cost.

We will not confine this article to the subject of economical methods of determining the cost of production, but to show that it is economy to find definitely the cost of production, regardless of the expense involved, and endeavor to prove it to be, "that management which expends money to advantage." We are inclined to think that some foundrymen consider the value of a cost system, as did the writer of the following letter, the endowment of college chairs (if you will pardon the comparison).


P.C.F.CO.ORDER NO.
DATE SHIPPED
CAR NO. & INITIAL
VIA

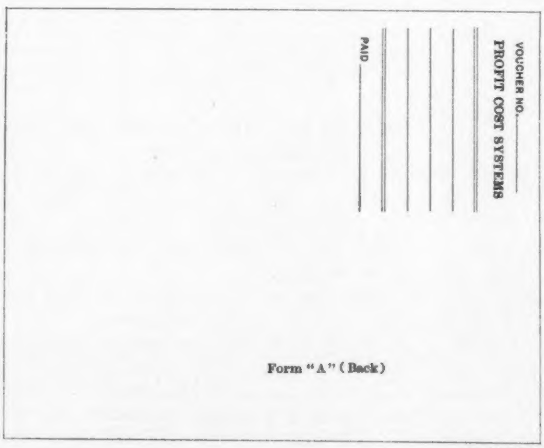
PROFIT COST SYSTEM
FOUNDRY COMPANY,

PRICE CORRECT
MATERIAL RECEIVED
WEIGHT CHECKED

DATE
DR. TO
ADDRESS
TERMS: NET DAYS, LESS PER CENT. DAYS.

AUTITOR'S CHARGES
ENTERED
[illegible]
FOLIO
MATERIAL RECORD
FOLIO
SUPPLY RECORD
FOLIO
CALCULATIONS CORRECT·
APPROVED:
SUP'T

Form "A" (Front) *The Foundry*


PROFIT COST SYSTEMS
VOUCHER NO.
PAID

Form "A" (Back)

The Foundry

"Lone Tree, April 10, 1903.

"President: Can you preach at Lone Tree church the last Sunday in April, and then go home with me to dinner? Mother and me wants to endow two chairs in your college. Very truly,

"Jonas Smith."

He joyfully accepted the invitation after discovering that Jonas Smith was a very wealthy farmer, to whom the endowment of two chairs would work no hardship. After the dinner which followed the sermon the conversation came to the important subject in hand, and the farmer said: "Now, I know you can buy a good, strong, stout chair for fifty cents; but we want to do more than that for the college, and mother and me have decided that we are willing to give seventy-five cents each to endow two chairs, one for mother and one for me."

Now, gentlemen, remember that everything about a foundry is very heavy (unless it be the profits) and hard on furniture; so if any of you consider the endowing of an extra shelf and stool for cost-finding it will be economy to procure the 75c style. A faulty system may leave you in the dark; a miscalculation may make a leak in the profits that is hard to trace. Your margin of profit is in your books, and it is not only necessary for you to know whether you are losing or making money, but to know where you are making, or if losing, to get some idea how to stop the loss. Even though making money, there may still be some leaks which, if stopped, would increase the profits. A good system of bookkeeping, properly executed, is worth thousands of dollars to you. By this we mean sales and purchase ledgers with a cost system so interwoven that with each month's balance, they produce a systematic comparison of accurate detail costs, of each casting, each job or order or each class of castings, as the case requires.

The managers who look upon system as unnecessary red tape, are not managers of

the shops paying the largest dividends. Their systemless methods require the most of their time attending to minor details, which under a proper system would be better cared for by an assistant at $10 per week. System has been termed "the ability to multiply ourselves in others." With this ability we have the large modern shops; without this ability, the old time establishments in which the matter of accounting is considered of little importance. If this truth be the sequel of the small percent of modern foundries of today, then it would certainly be economy to endow a 50-cent

PROFIT COST SYSTEMS

VOUCHER-CHECK.

TO

FOR INVOICES AS FOLLOWS:

DATE	DESCRIPTION	AMOUNT	AMOUNT
	FULL VALUE OF INVOICE RENDERED		

ACCOUNT AND EXTENSIONS CORRECT

APPROVED FOR PAYMENT

GEN'L MANAGER

IF NOT CORRECT RETURN WITHOUT ALTERATIONS AND STATE DIFFERENCE.

Form "B" (Front)

The Foundry

MAKE ALL ENDORSEMENTS BELOW

Form B (Back)

PROFIT COST SYSTEM CO.

No. LORAIN, OHIO,

PAY TO THE ORDER OF $

DOLLARS
100

TO PROFIT COST SYSTEM CO.

TREASURER.

The Foundry

chair for costing, but remember a stronger one for 75 cents will give better satisfaction.

We may be able to keep a small business afloat without this systematic detail, but the same displacement that carries a small boat will not bear up a large vessel; if we aspire to a greater number of large prosperous foundries, we must set sail to catch the breeze, systematic accounting, that will waft us on. You improve and repair your riggings, put in various kinds of molding machines, etc., but your way of accounting has run on and on without oil or repairs, until the old system is breaking down under the load. In fact if the bookkeeper asks for an extra card or form with which to patch it up, it is allowed only after considerable persuasion, and an extra clerk is not to be thought of.

Why continue this "improper saving of expense"? We have our organizations for everything except accounting, why not a section for cost-finding?

Repair and improve the worn-out methods, stop the friction, and you will be surprised at the amount of power saved and the ease with which your business will run. The advantages of such an organization would be many. Large corporations pay their accountants large salaries for their ability to systematize. Of course, the volume of business done by the majority of our foundries will not admit of a man of this ability as the head of their accounting,

Cupola No. ______ Daily Charge Sheet ______ 190__

Product	Estimated Weight												Total
Total													
Charge													
Total													

Form "F"

The Foundry

but some such method as suggested would be of assistance in the betterment of foundry accounting, or, an organization of this kind could have in its employ a man of this ability, to assist its members in formulating better systems for the handling of their business.

The point we have tried to make is this, that if you are trying to increase your profits by the little you can save by producing without ascertaining the cost, and just what constitutes that cost, you are working with too short a leverage; dividends are not made in that way. We are well aware that many are aroused to the need of this knowledge, but few are fully awake to the fact that the expense involved in finding the cost, means an increase and not a decrease in the dividends; that every dollar so expended, by a proper system, will return to your coffers twofold. For fear we have failed in making this plain, let us relate the actual experience of an economical (?) manager increasing the dividends for his company by using and re-using old nails. It

Materials Received, PROFIT COST SYSTEMS													
Date Rec'd	FROM.	Via Fgt or Exp.	DESCRIPTION.	Weight.	FREIGHT		Exp.	INVOICE.					Remarks.
					Via C.L.&W.	Via N.Y.C.&St.L.		Date.	WEIGHT. Net.	Tons.	Lbs.	Amount.	

Form "C" *The Foundry*

was during the time when nails were selling at 90 cents per keg, that this economical manager had boys employed to gather nails out of the sand and straighten them; which the molders used in place of new ones. After an article published in the Iron Age, showing the small fractional cost of one nail, and setting forth the fact that if a carpenter receiving $2.50 per day dropped a nail upon the ground at his feet, the value of his time, required to pick up that nail, was greater than the cost of a new nail taken from his pouch; this manager, who, by the way, was operating a shop with some 400 employes, set about to find the cost of his second-hand nails, and was much surprised to learn that he was paying three times as much for old rusty nails as new ones would cost; needless to say, those boys were set at other work. This is but one of many similar experiences we could recite, but this simple one fully illustrates the fact that "some expenditure is economy and some economy the wildest kind of extravagance."

Record of Metal Costs for Month of 190											
DESCRIPTION.	DATE	GOOD CASTINGS.		BAD CASTINGS		GATES, SCRAP, ETC.		LOSS.		TOTAL CHARGE.	
		WEIGHT	AMOUNT	WEIGHT	AMOUNT	WEIGHT	AMOUNT	WEIGHT	AMOUNT	WEIGHT	AMOUNT

Form "K" *The Foundry*

The Kind of a System.

The writer has read many articles upon foundry-costing and with but one exception the subject was treated upon an estimating basis. The day of estimated costs departed in company with "large profits." The small margin of today demands accuracy and reliable detail. The costs are of small value which do not represent the exact expenditure as shown by the ledger balance; in other words, ledger balance costs. With these we not only know that nothing has been overlooked or omitted, but that no clerical errors have been made. With

Cupola No.1		Total	Cupola No.2		Total
ESTIMATED WEIGHT OF PRODUCT			ESTIMATED WEIGHT OF PRODUCT		
TOTAL CHARGE			TOTAL CHARGE		
GOOD CASTINGS			GOOD CASTINGS		
BAD CASTINGS			BAD CASTINGS		
	GATES AND SCRAP			GATES AND SCRAP	
	LOSS			LOSS	

Air Furnace No.1 Heat No.		Total	Air Furnace No.2 Heat No.		Total	Crucible Furnace	Total	Babbitt Metal	Total
ESTIMATED WEIGHT OF PRODUCT			ESTIMATED WEIGHT OF PRODUCT						
TOTAL CHARGE			TOTAL CHARGE			TOTAL CHARGE		TOTAL CHARGE	
GOOD CASTINGS			GOOD CASTINGS			GOOD CASTINGS		GOOD CASTINGS	
BAD CASTINGS			BAD CASTINGS			BAD CASTINGS		BAD CASTINGS	
	GATES AND SCRAP			GATES AND SCRAP		GATES AND SCRAP		GATES AND SCRAP	
	LOSS			LOSS		LOSS		LOSS	

Form "L"

The Foundry

SHOP ORDER.

Please make Lorain, Ohio, ...

For.. On their Order No.

		Totals
Description,		
Date made,		
No. pieces cast,		
No. pieces good,		
Description,		
Date made,		
No. pieces cast,		
No. pieces good,		

Ship to ....

Via.................................... Shop Order No. ....

Form "M" *The Foundry*

estimated costs there is no proof against any of these errors and no accurate profits can be based upon them.

I wish to correct the prevailing impression that a ledger balance system is an expensive one. If accuracy was required in

PROFIT COST SYSTEMS CO.

COST SHEET for Month of..

	THIS MONTH		LAST MONTH		TO DATE		LAST YEAR
	No. Pcs. Avg. Lbs.		No. Pcs. Avg. Lbs.		No. Pcs. Avg. Lbs.		No. Pcs. Avg.
	AMOUNT	AVERAGE	AMOUNT	AVERAGE	AMOUNT	AVERAGE	AVERAGE
MATERIAL Metal,							
Furnace Loss,							
Bad Casting Loss,							
Melting,							
Gates and Scrap Loss,							
Total,							
DIRECT CHARGES Molding Sand,							
Core Sand,							
Brick							
Accessory Castings,							
Core Oven Cost,							
Total,							
MOLDING AND CLEANING Molding Labor,							
Core "							
Direct "							
Cleaning "							
General "							
Total,							
SPECIAL CHARGES Machine Work,							
Defective Loss,							
Special Expense,							
General Charges,							
Total,							
Total Cost,							
Operative Labor,							
Total Hand Account,							

	POUNDS	PER CENT	POUNDS	PER CENT	POUNDS	PER CENT		PER CENT
Good Castings,	Lbs.		Lbs.		Lbs.			
Furnace Loss,	"		"		"			
Bad Castings,	"		"		"			
Gates and Scrap,	"		"		"			
TOTAL CHARGE,	Lbs.		Lbs.		Lbs.			

Form "S" *The Foundry*

many of the "come somewhere near" systems, the ledger balance system would in every instance require the least expenditure of both labor and money. With a ledger balance system you can not say $6 \times 4.25 = 15.50$ and never know that that job cost you $10 more than your figures represent; everything must fill out a certain place and if too much or too little, you soon find it out. With a system of this kind, the chief desideratum of every entry is to know the cost of production. Each book, form and card used have in them the threads, which are automatically woven into the aggregate cost, which consist of as many different colors of thread or detail as required.

The first step towards a ledger balance cost system is the voucher method, for the handling of accounts payable; with this we include petty cast expenditures and payrolls, in fact, all money paid away. A voucher system can be used without a ledger balance cost system, but the reverse is not desirable. Forms A and B make a very satisfactory voucher, plain and easily understood, yet giving all necessary information. Form A always accompanies an order with a request that invoice be rendered upon the accompanying blank. This is printed in copying ink, enabling the shipper to make an impression copy for his records, thus avoiding extra manifolding at either end of the line. When received from the shipper as an invoice rendered, it shows the order number upon which shipment of material, charged thereon, was made, date, car number and route of shipment. This is first used by the buyer who checks the price, makes note of shipment upon his copy of the order on which shipment applies and inserts auditor's charges. It is then passed to the receiving clerk, who checks the weight or quantity and marks date material is received. It now goes to the bookkeeper who checks the calculations and after numbering

it, makes the necessary entries. It is then approved by the superintendent and passed to the stenographer who fills out a corresponding form "B" and returns both to the bookkeeper or auditor for certifying form "B." Forms "A" and "B" are now folded together and given to the general manager or president, who approves for payment form "B," which is then passed to the treasurer for payment. Form "A" is now filed away and when form "B" is returned through the bank, it is filed with form "A"; thus not only making a complete record, but also rendering it impossible for the paying away of any money without the knowledge of the proper officials. Any number of "A" forms can be stapled and made up into one voucher, cutting off at line of auditor's charges, all except the last one, which bears charges and approval for all.

A book which is a purchase ledger, voucher record, and transfer journal combined, and known as an "Operation Record," is a labor saver, and if properly designed, a very satisfactory arrangement for any foundry business. This makes a complete record of accounts payable and contains place for the detailing of the cost of the various productions. A separate ledger is required for the detailing of material in stock, that is, pig iron, coke, coal, sand, limestone, etc. Chaplets, facings and molders' supplies of all kinds, should be charged to an account known as "store" or "supplies," and put in charge of someone who delivers same to molders, as required, and makes report of all such deliveries, that said account may be credited and charge made against proper job.

All pig iron and coke of course is weighed when delivered to cupola and reported daily. Form "F" is designed for this purpose, where a variety of castings are made, requiring an entirely different mixture. The lower part instructs the cupola men how the iron is to be charged into the cupola, and the top part gives the amount and kinds of iron charged for each job or grade of castings. Where the total cast requires practically the same mixture of iron, a more simple form answers this purpose. Forms "K" and "L" are used in compiling the cost of metal, cupola loss, bad casting loss, etc.

When an order is received, a shop order, form "M," is made, and customer's order stamped "entered" shop order No. — which is then filed and ordinarily not referred to again. Upon form "M" is recorded daily the number of castings made from each pattern, and later the number which proves good. A shipping form is made in carbon at the same time form "M" is made out, ruled as to record dates and quantity of shipments made. When an order has been filled, forms "M" and "M1" are bound or filed together in numerical order. There is also a shop order card for following the work through the shop, made from the original order, for each pattern showing the number of pieces and kinds of metal required. Form "O" is a daily record of all

PROFIT COST SYSTEMS

CAST OF________________190________

[illegible]	[illegible]	[illegible]	WEIGHT		MOLDER	MADE FOR	DESCRIPTION	SHOP ORDER	No. Pcs. Cast	SHIPPED	GOOD CASTINGS		BAD CASTINGS		CHANGED
			Good	Bad							Pcs.	Weight	Pcs.	Weight	

Form "O" *The Foundry*

Name________ Name________ Name________

Class of Work________ Class of Work________ Class of Work________

	DATE	WAGES PER DAY	TOTAL HOURS WORKED	TOTAL NO. PCS. CAST	WT. PER DAY GOOD	% BAD	DATE	WAGES PER DAY	TOTAL HOURS WORKED	TOTAL NO. PCS. CAST	WT. PER DAY GOOD	% BAD	DATE	WAGES PER DAY	TOTAL HOURS WORKED	TOTAL NO. PCS. CAST	WT. PER DAY GOOD	% BAD

Form "P" *The Foundry*

castings made; the information for which is received by means of the shop cards. With this record is made a carbon copy for the weigh-master's or cleaning room's report of castings.

From form "O" is secured information for forms "K," "L," "M," "N" and "P." Form "P" is designed for a molder's individual record, which by taking the average per week for each molder, as recorded by form "O"; each "P" form is printed on each side and so will accommodate the record of six molders for one year. This information could be conveniently kept in card form if preferred, but the sheet has some advantages over the card.

Form "C" makes a desirable receiving record for use in connection with forms "A" and B." The part shown is for local receipts; a very convenient arrangement is to have one part of the book for local and another part with a little different ruling for carload receipts, instead of separate books.

PROFIT COST SYSTEMS __________ OPERATIONS, for Month of __________ 190____

	THIS MONTH			LAST MONTH			TO DATE			LAST YEAR, TO DATE		
	Pounds	Price	Amount	Pounds	Price	Amount	Pounds	Price	Amount	Pounds	Price	Amount
Stock,												
Made,												
Total,												
Used,												
Balance,												
Sold,												
Defective Loss,												
Prices Rec'd,												
On Hand,												
Total,												
Profit,												

Form "T" *The Foundry*

The Result Obtained.

Time will not permit a thorough explanation of a ledger balance system, and we will now refer briefly to the results obtained by such a system. This can best be done by a cost sheet form "S." The number of these sheets, each to represent a different job, or product, are without limit, and can be modified to suit any class of work. Separate exhibit sheets are made for melting cost, core oven cost and general charges; showing the details for the aggregate of these charges, which are prorated over the different products. The item "general charges" embodies salaries and office expenses, laboratory, taxes, insurance, water, light and power, crane service, molder's supplies, etc. Form "T" is the final or earning statement, one of which is made for each cost sheet, and which you will note, makes, identical with the cost sheets, a comparison with the preceding month, year to date and previous year to date.

The profit shown thereon monthly, is exactly what will be shown by the ledger at the close of the year. In fact each month is as much the close of the year, as is the twelfth month, so far as the books and earnings have to do with it. Supplies, fuel and pig iron are inventoried whenever the stock is low and product on hand checked monthly. The proper checking out of form "T" reveals any errors in billing, either in calculations or weight, or the failure to bill any shipment.

With a ledger balance system, each item, card, book, form, or whatsoever is a part of the whole and will form the grand results without any friction or commotion so long as each interested party performs his or her part, and this in itself prevents carelessness upon the part of any individual. All forms requiring the workman to perform clerical work, should be eliminated, and all entries should be so connected that no matter where you pick up a thread of information it can easily be followed to the start or finish. The writer was recently asked for the weight of a 30-ton electric crane, which had been installed and in service for eight years. The crane of course had not been purchased by weight, therefore it would be waste of time to refer to the invoice. The weight up until this time had been of no importance or special note made of it. How shall we find it? It is wanted immediately. Oh, yes! we can get that from the receiving book; let's see, that was purchased in 1896. In referring to the

receiving record, we learn that it was received upon three cars, two of which were a double load and for that reason had not been weighed. The one car which had been weighed contained but a small part of the crane, but with this information, the railroad expense bill was easily located which contained the weight of the entire shipment, and within ten minutes from the time this information was desired, we were in possession of it.

We only quote this instance to show what unexpected information a good system properly executed will furnish upon short notice.

"There's a vast difference," says someone, "between having a carload of miscellaneous facts sloshing around loose in your head and getting all mixed up in transit, and carrying the same assortment properly boxed and crated for convenient handling and immediate delivery."

LOSS IN MALLEABLE FOUNDRY.

BY R. F. FLINTERMAN, CHICAGO, ILL.

It may be of interest to see in detail the results of a number of test heats lately made at McCormick Works, International Harvester Company, to determine the amount of loss and shrinkage in malleable work. The melting was done in ordinary air furnaces. In tables Nos. 1 and 2 it is shown in detail how the various heats were made up and also the total amount of iron recovered, both as castings and as scrap (sprue, floor riddlings, mill riddlings, etc.). The difference between total iron recovered and heat as made up gives the loss or shrinkage, this loss running from 3.36 per cent. to 8.03 per cent.

TABLE NO. 1.

Test Heats Taken in Malleable Foundry, May 2d, 1904

	Heat No. 1		Heat No. 2		Total	
	Pounds	Per cent of Melt	Pounds	Per cent of Melt	Pounds	Per cent of Melt
Pig Iron	14,720		9,755		24,475	
Sprue	15,200		10,520		25,720	
Total Iron Melted	29,920		20,275		50,195	
Product						
Iron from Milling Slag	159	00.53	327	01.61	486	
Scabs from Furnace Spouts	145	00.49	210	01.04	355	
Sprue (Includes Floor Riddlings)	12,035	40.22	7,927	39.10	19,962	
Total Scrap	12,339	41.24	8,464	41.75	20,803	
Castings (Good and Bad)	16,304	54.49	11,130	54.89	27,434	
Total Product	28,643	95.73	19,594	96.64	48,237	
Loss	1,277	04.27	681	03.36	1,958	
Slag from Skimming Heat	1,249	04.17	1,545	07.62	2,794	
Iron Recovered from Slag	159	12.	327	21.17	486	

TABLE NO. 2.

Test Heats taken in Malleable Foundry, May 19, 1904.

	Heat No. 3		Heat No. 4		Total	
	Pounds	Per cent of Melt	Pounds	Per cent of Melt	Pounds	Per cent of Melt
Pig Iron						
Car No. 61302	12,000	50.00	4,500	18.74	16,500	34.36
" " 70988			7,500	31.22	7,500	15.62
Total Pig Iron	12,000	50.00	12,000	49.96	24,000	49.98
Sprue	12,000	50.00	12,020	50.04	24,020	50.02
Total Iron Melted	24,000	100.00	24,020	100.00	48,020	100.00
Iron recovered from Milling Slag	234	00.97	266	01.11	500	01.03
Scabs at Furnace Spouts	155	00.65	250	01.04	405	00.85
Mill Riddlings	28	00.12	29	00.12	57	00.12
Sprue (includes Floor Riddlings)	8,983	37.43	8,954	37.27	17,937	37.35
Total Scrap	9,400	39.17	9,469	39.51	18,899	39.35
Castings (Good & Bad)	12,673	52.80	13,532	56.34	26,205	54.57
Total Product	22,073	91.97	23,031	95.88	45,104	93.92
Loss or Shrinkage	1,927	08.03	989	04.12	2,916	06.08
Slag from Skimming above heats	1,618	06.74	1,817	07.56	3,435	07.15

It is further attempted to ascertain as nearly as possible to what cause the loss and shrinkage might be due. Below are given in detail the method employed for determining the character of the loss due to the chemical changes of various kinds.

Mixture was made up of pig iron and sprue, the composition of which is shown in Table No. 3.

TABLE NO. 3

	Silicon	Sulphur	Phosphorus	Manganese	Total Carbon
14720 lbs. Pig Iron	1.51	.036	.168	.693	3.72
15200 lbs. Sprue etc	1.10	.054	.130	.388	2.56

TABLE NO. 4

	Silicon	Sulphur	Phosphorus	Manganese	Total Carbon
Analysis of mixture as it went into furnace	1.30	.045	.149	.53	3.13
Analysis of hard iron tapped from furnace	.85	.077	.160	.33	2.55
Loss	.45			.20	.58-1.23 %
Gain		.032	.029		.061
Total loss					1.169 %

Slag Analysis.

Tr. total amount of Slag .... 1249 lbs.
Iron recovered in Sly Mill. .... 159 "

Slag residue .... 1090 lbs.

This would make the composition of the mixture as it went into the furnace as given in Table No. 4. For sake of comparison we give also analysis of the hard iron, that is, of the finished product as it is tapped from the melting furnace. This shows plainly what changes occur and at same time shows what losses are due to such chemical changes:

This slag was carefully sampled and was found to analyze as follows:

Metallic Iron (removed by magnet)	5.20%
" " (determined by titration) part present as Ferric Oxide and part present as Metallic Iron	21.51-32.4 Ferric Oxide
Alumina	14.50
Lime	.85
Silica	51.38

Total iron including that removed by magnet and that determined by titration amounts to 26.7 per cent., which represents iron lost and not recoverable. This accounts for 291 lbs. (26.7 per cent of 1090 lbs.) and amounts to .90 per cent. of total mixture.

Thus by reason of chemical changes during melting and by determining amount of iron contained in slag and not recoverable, we have accounted for the following: 1.169 plus .90 equals 2.069 per cent.

The total loss as per report already made (Table No. 1) amounted to 4.27 per cent., which leaves 2.2 per cent. still unaccounted for. This loss may be accounted for in the following manner:

Our mixture as given hereinbefore contained pig iron and sprue. The sprue had previously all been rattled and may be counted as clean iron. The pig iron is, of course, more or less oxidized and also sand coated. Accepting 10 per cent, as figure represented by sand present, 1472 lbs. of sand were weighed up and counted as iron.

Now, referring to Table No. 1, it will be noted that among the various products of the melt we have 1235 lbs. of sprue. This sprue as returned includes sand adhering to it. By actual test we have determined that this sand amounts to 7.5 per cent. of the weight of the sprue. We are, therefore, turning in as iron in our product record 902 lbs. of sand (7.5 per cent. of 12035 lbs.) 1472—902 equals 570 lbs. The other products as reported are all cleaned up before weighing. The 902 lbs. of sand adhering to sprue in product partially offsets the sand weighed up with pig, but still leaves 570 lbs. of sand which must have passed into slag. This 570 lbs. amounts to 1.9 per cent. of total mixture, thus making total loss accounted for 1.9 plus 2.07 equals 3.77 per cent. which is within .30 per cent of loss as reported.

If 10 per cent. is considered too high for the amount of sand adhering to pig iron, this last loss as accounted for will, of course, be reduced.

There will be further loss which cannot be determined, as for instance, the oxidized iron on inside of furnace which has passed into bottom; there may be other slight losses due to various causes. However, losses other than those accounted for cannot be very great. It would appear, therefore, that the loss of 4.27 per cent. is about right.

Concerning figures as herein given will say that the analysis of sprue which was put into mixture was obtained by taking 10 pieces of hard iron; borings were taken from each of these pieces, the borings were mixed and then analyzed.

In order to get at the analysis of the finished product, three test bars were taken at beginning, middle and end of tap. The bars were sampled and borings were mixed and analyzed.

We add now figures for next three test heats, all sampling, calculation, etc., having been made in same manner as with No. 1 heat, which we have just explained in detail.

TABLE NO. 5.

Heat No. 2.

	Silicon	Sulphur	Phosphorus	Manganese	Total Carbon
6790 lbs. Pig Iron	1.51	.036	.168	.693	3.72
2965 lbs. Pig Iron	1.67	.017	.120	.737	3.60
10520 lbs. Sprue etc.	1.13	.066	.152	.349	2.77
Analysis of Mixture	1.33	.048	.152	.520	3.21
Analysis of Metal as tapped	1.03	.073	.160	.330	2.66
Loss	.30			.190	.55—1.04
Gain		.025	.008		— .044
Total loss					—1.007

Slag Analysis.

Total amount of Slag	1545 lbs.
Iron recovered by Sly Mill	327 "
Slag residue	1218 lbs.

Analysis of Slag Residue.

Metallic Iron (removed by magnet)	11.7%
" " (determined by titration)	24.3
Silica	46.2

Total Iron not recoverable equals 36% of slag residue—equals 438 lbs. The Iron not recoverable amounts to 2.1% of total mixture.

Loss due to Sand.

9755 lbs. Pig Iron (10% sand) carries..........975.5 lbs. Sand
7862 " Sprue (7½% sand) " ....589.5 " "

Difference..........386.0 lbs. Sand
This loss amounts to 1.9% of total mixture.

Total Loss in Detail.

Due to chemical change..........1.01%
Due to iron which cannot be recovered from slag..2.10
Due to sand loss..........1.90

5.01%

These figures are 1.65% in excess of loss as reported in Table No. 1.

TABLE NO. 6.

Heat No. 3.

	Silicon	Sulphur	Phosphorus	Manganese	Total Carbon
12000 lbs. Pig Iron..........	2.00	.025	.12	.78	3.81
12000 lbs. Sprue	1.08	.057	.16	.17	2.37
Analysis of Mixture..........	1.54	.046	.14	.47	3.09
Analysis of Metal as tapped..........	1.25	.057	.16	.31	2.46
Loss..........	.29			.16	.63—1.08
Gain..........		.011	.02		—.031
Total loss..........					—1.049

Slag Analysis.

Total amount of Slag..........1618 lbs.
Iron removed by Sly Mill..........234 "

Slag residue..........1384 lbs.

Analysis of Slag Residue.

Metallic Iron (removed by magnet)..........14.1%
" " (by titration)..........22.7
Silica..........47.9
Alumina..........15.4

Total Iron not recoverable equals 36.8% of slag residue, equals 509 lbs. The Iron not recoverable amounts to 2.1% of mixture.

Loss due to Sand.

12000 lbs. Pig Iron (10% Sand) carries 1200 lbs. Sand.
8983 " Sprue (7.5% ") " 674 " "

Difference.......... 526 " "
This loss amounts to 2.2%

Total Loss in Detail.

Due to chemical change..........1.05
Due to iron which cannot be recovered from slag, 2.10
Due to sand loss..........2.20

5.35%

Figures as reported by Table No. 2 are 2.68% in excess of this.

TABLE NO. 7

Heat No. 4.

	Silicon	Sulphur	Phosphorus	Manganese	Total Carbon
4500 lbs. Pig Iron..........	2.00	.025	.12	.78	3.81
7500 lbs. Pig Iron..........	2.46	.013	.14	.79	3.48
12020 lbs. Sprue	.99	.076	.17	.25	2.21
Analysis of Mixture..........	1.64	.045	.15	.52	2.90
Analysis of Metal as tapped..........	1.33	.055	.15	.31	2.67
Loss..........	.31			.19	.23-.73
Gain..........		.01			-.01
Total loss..........					-.72

Slag Analysis.

Total amount of Slag..........1817 lbs.
Iron removed by Sly Mill.......... 266 "

Slag Residue..........1551 lbs.

Analysis of Slag Residue.

Metallic Iron (removed by magnet)..........18.5%
" " (determined by titration)..........19.7
Silica..........43.2

Total iron not recoverable, 38.2% of Slag residue, equals 592 lbs. The iron not recoverable amounts to 2.4% of mixture.

Loss due to Sand.

12000 lbs. Pig Iron (10% Sand)..........Carries 1200 lbs. Sand
8954 " Sprue (7½% ").......... " 671 " "

Difference.......... 529 " "
This loss amounts to 2.2%

Total Loss in Detail.

Loss due to chemical change.......... .72%
" " " iron which cannot be recovered by Sly Mill.......... 2.40
Loss due to sand loss.......... 2.20

5.32%

This figure is 1.2% in excess of loss as shown by Table No. 2.

TABLE NO. 8

Recapitulation.

	HEATS				Average
	No. 1	No. 2	No. 3	No. 4	
Loss due to chemical change..........	1.17%	1.01%	1.05%	.72%	.98%
Loss due to iron not recoverable..........	.90	2.10	2.10	2.40	1.87
Loss due to sand loss	1.90	1.90	2.20	2.20	2.05
Total loss..........	3.97	5.01	5.35	5.32	4.90
Total loss as shown by Tables No. 1 and 2...	4.27	3.36	8.03	4.12	4.94

These figures go to show that 5 per cent. loss should be about maximum loss for our practice. While there is more or less lack of correspondence in results as obtained, the results are nevertheless near enough alike to show that a loss of 8.03 per cent. as shown on No. 3 test cannot be right. This excessive loss must be due to some error in weighing back product of melt, since there is nothing in analysis of figures of this heat to account for loss being so much higher.

PAYMENT OF LABOR.

DISCUSSION BY KIME I. SMITH, PROVIDENCE, R. I.

The paper read at Indianapolis by Mr. John Magee, brings into prominence once more the important study of the wage question, enumerating as it does the various schemes for the remuneration of labor. In my opinion, these may be simmered down to two prevailing methods, viz., day work and piece work, for after all what is the premium scale if it is not piece work, with a lump of the mechanic's earnings sliced off? For example, let us take a side floor which nets the molder $4.00 for a certain piece, and through hustling he is able to close his molds by 2:00 p. m. The foreman comes along with a job which pays $1.00, and wants it that afternoon. Perhaps for want of room he is obliged to utilize every available space to increase production. Would it be just for the proprietor to step in and take a share of the molder's wages? Not by any means, since we get 25 percent increased production in a given space. And yet we hear of the good features of the premium system.

I have had considerable experience with day work and piece work methods, and the latter has many strong points in its favor, but to conduct either one successfully requires a man thoroughly drilled in the art of molding, together with many other requirements. He must always be able to maintain his standing as a gentleman, whether it be in fixing the price of a job or in determining a day's work, and his decision should be with fairness to the employer and justice to the employee. If these principles predominated, instances of discontented labor and failures in foundry enterprises would be less frequent.

THE PREMIUM PLAN.

DISCUSSION BY JOHN MAGEE.

The recent article by Mr. K. I. Smith contains much that is of interest and, with all due respect to the writer, much that lacks appreciation of the real principle involved. Mr. Smith states that the whole discussion may be simmered down to two prevailing methods for paying labor. This is undoubtedly correct but as far as that goes his two could be boiled down again to one under the heading "Wages," in which the subject matter could consist of five words "Wages are paid for work." Probably a slight examination would show that even that statement is too verbose.

But be all that as it may, the chief interest of the article lies in the fact that it gives expression to a very general fallacy in regard to the premium plan for the payment of labor.

In Mr. Smith's discussion of the system one remarkable thing is to be noted—there is no reference in any way to the premium, a rather important detail which seems to have been overlooked. Somewhat the same mistake is made in a recent article in the Iron Molders' Journal.

Let us analyze Mr. Smith's version a little, putting it right as we go along.

The molder had a piece which netted him $4.00 per day. In a premium shop it would be known as a seven-hour piece (a day's pay being based on seven hours' molding) and his regular pay would be $.571 per hour. So far we have regular day work except that the molder is paid only for the time he spends molding, and his labor pouring off, etc., is thrown in, so to speak. Of course the total day's pay is the same as it would be in straight day work.

Now in this shop that we have taken for illustration we have the premium, which can be placed at $.30 per hour for the sake of illustration. Now let us imagine Mr. Smith's $1.00 piece sent in to the shop (only it would go under the name of a seven-hour piece).

If our molder uses all the seven hours allotted (and bear in mind that the time allowed must be fair) he would have for his day's pay seven hours at $.571, or $4.00.

Now let us suppose that he does the work in six hours. He will then get six hours' pay at $.571 or $3.43; but it does not end there, for he also gets a premium of $.30 for doing the work in one hour less than the allotted time so that his total pay for the *six* hours would be $3.73. Now he still has one hour before the wind goes on so his foreman sends him a one-hour piece and he earns another hour's wages, making a total day's pay of $4.30 or an increase of 7.4 percent over the regular day's pay which is paid him for the extra hustle. Should he also shorten his time on the second piece his pay would be still greater.

Now the manufacturer on his side has received work that would have cost $4.59 with a slow man, for a total cost of $4.39, a saving to him of $.27 or 5.9 percent.

In other words, by saving an hour in doing the larger piece and using the time so saved on another piece, the molder has received 7.4 percent extra on his day's pay and the work has cost the employer 5.9 percent less.

Note that the employer's share is not robbed

from the employe, for he has earned more than seven percent over a fair day's pay already.

Can anyone explain how "the proprietor has stepped in and taken a share of the molder's wages?"

It is always to be kept in mind that the larger the premium the larger the increase received by the workman until in the extreme case when the premium equals the hourly wage, the system becomes straight piece work. In this article there has been no attempt to show where the premium plan finds its application, but only *what* the plan is.

There are many uses for a system that fits in half way between day and piece work and the premium plan with the disadvantages of neither and with many advantages of its own seems often to serve the purpose.

Employees should seriously consider that a man is never paid less than a day's pay, which is not true of piece work where prices are set for the average man and any falling below that line do not receive full wages.

The following table shows the working of the premium plan under different rates of speed and with different premiums per hour.

In each case it is supposed that a seven hour piece be done in the time shown at the left and that the same rate of speed be maintained for the rest of the seven hours.

Wages $4.00 for seven hours actual molding, and two hours incidental work.

A PATTERN CARD RECORD.

In connection with the report of the committee on insuring patterns, a standard card was proposed for keeping a record of the patterns. This card is 3 by 5 inches and is printed as shown in the accompanying illustration. It will be noticed that all of the points covered in the report and the discussion are provided for in the card.

INDEX NO.______ OWNER______

PATTERN SYMBOL______ NO. PIECES______ DRAWING NO.______

LOCATION: SECTION______ RACK______ SHELF______

NAME OF CASTING______ USED ON______ DESIGN OF______

SEE INDEX FOR______ CORE BOXES,______ FOLLOW BOARDS,______ MATCHES,______ CHILLS.

VALUE: COST LABOR______ HOURS______ @ ______ $______

MATERIAL (KIND)______ @ ______ $______

TOTAL COST, $______

(IN CASE NOT ACTIVE) CLASS______ DEPRECIATION CHARGES, $______

VALUATION, $______

DATE LAST USED______ 190__ WEIGHT ROUGH CASTING ______ LBS.

ACCT. WORKS ORDER NO.______ " FINISHED " ______ LBS.

FOR REMARKS SEE REVERSE SIDE.

The Foundry

Table Illustrating Premium System.

Premium for each hour saved	10c.	20c.	30c.	40c.
Work done in seven hours costs	$4.00	$4.00	$4.00	$4.00
% gain in pay to employee......	0	0	0	0
% saving to the employer........	0	0	0	0
Work done in six hours costs...	$4.12	$4.23	$4.35	$4.46
% gain to employee	3%	5.7%	8.8%	11.5%
% saving to the employer........	16.7%	13.%	10.%	7.3%
Work done in five hours costs	4.21	4.56	4.84	5.12
% gain to employee	5.2%	14.%	21.%	28.%
% saving to the employer........	34.8%	26.%	19.%	12.%
Work done in four hours costs	4.52	5.05	5.57	6.14
% gain to employee................	13%	26.2%	39.3%	53.6%
% saving to the employer........	62%	48.8%	35.8%	21.5%

A PATIENT CARD RECORD

[illegible]

DISCUSSION ON "SHOT IRON."

BY THE FOOS MFG. CO., SPRINGFIELD, O.

We use one of the large sized Sly Cinder Mills to remove the shot iron from the cupola slag, and find it a paying investment. Our method of operation is about as follows:

During all seasons save when the weather is extremely cold we reclaim the iron daily, but during the months of January and February we have been in the habit of putting the machine out of commission, allowing the slag to accumulate, and then as soon as the weather will permit, we begin operations and within a few weeks have the accumulation out of the way. During this period we usually reclaim more iron than we are able to melt each day, as at this season of the year our foundry heats are rather small. There is a period, therefore, during several weeks when the amount of iron reclaimed is somewhat in excess of the amount melted, but as we always protect the excess from weather conditions, the corrosion is not very marked where it is not to remain unused for a considerable length of time. We believe it is very much better to re-melt this shot daily, and under these conditions there is no possibility of it giving any trouble in the cupola. Our method of handling it is as follows: We do not make any charge of the shot on the first four heats, nor on the last two heats, but on each of the charges between. Our charges are made up as follows: 700 lbs. of iron and 300 lbs. of shot, and this would continue throughout the heat except as stated above. There have been times when we have used a greater proportion of the shot, but we find this combination to work very satisfactorily in our cupola and on our work. A fair proportion of our work is gas engine, exploder boxes, etc., and we think you will agree with us that this class of castings are about as exacting in their requirements as any that are ordinarily made.

We recover our coke and allow it to accumulate until fall when we run it over a pneumatic separator which we have built for our own use, thus separating out all slag and other foreign material. Last winter we disposed of perhaps 50 tons to our employees who used it in furnaces in their homes and some in base-burners. From this one can judge of the quality and condition of the coke.

As to any trouble in the material going through the cupola and being discharged into the ladle without being re-melted. This will not result except the shot be allowed to remain for a long time after having passed through the machine, when we believe it might be sufficiently corroded to entrust it in the shell which might not melt in passing through the cupola, but when the shot is used daily there is not the slightest danger from this cause.

DISCUSSION OF "LABOR-SAVING SUGGESTIONS IN THE FOUNDRY."

BY J. H. SPRINGER SR., LOUISVILLE, KY.

I was much interested in Mr. Frohman's paper on the above subject, especially as so very many of the foundries of the country, and I might say right in his own district, need a lot of labor-saving devices to reduce costs. I was further interested, as in all my experience of fifty years as a foundry superintendent and owner, I have run across but few foundry supply men, who are really posted on the needs of the molding floor. If many of these hard working gentlemen would see how their products are often mutilated and mixed up in different ways to be of service for particular classes of molds it might be of value to them in their business.

I should like to have seen Mr. Frohman give us something more on foundry equipment in addition to taking up the small things. Here is where nearly all the general run of foundries are weak. It takes good equipment to do good work. A good cupola is wanted, good cranes, good sand, supplies, good small tools, and always kept in good condition. Flasks should be ready when the molder is given his pattern. Cores should be made in advance. It is not necessary that the owner should be a practical molder, but he should have a first-class foreman, a master in all the branches of the business.

Usually a foundry in charge of a good foreman, responsible for results, will be found pretty well equipped, for in our days a good man need not remain where he is not supplied with the requisites of his trade.

Mr. Jones is a manufacturer, has a large machine shop, builds machine tools, and requires about two hundred tons of castings per month, or fifteen thousand pounds of cleaned castings a day, which will keep an ordinary foundry quite busy. Mr. Jones invites bids, per pound, for this work delivered. As a rule the lowest bidder gets the work, and in most cases this will be below ordinary working costs. Then the foundryman begins to look about to cheapen production. He buys cheap pig iron, cheap coke, cheap supplies, etc. In

the end the castings are not satisfactory. The man who made the highest bid had a well equipped foundry, used good iron and supplies, and turned out good work. Mr. Jones would have done much better to patronize him, as he would have saved the difference in his machine shop. If Mr. Jones would do this next time, and others follow his example, the poor excuses of foundries would be driven out of business.

The foundryman should have system in his place. He should be able to locate all the items of his costs and keep them accurately for use in making bids. Thus with the amount of castings made as a basis, he should have the relation to this of the cost of flasks, supplies, cores, pig iron, scrap, skilled labor, common labor, and last, the general expense. If the foundryman does not know these things he is in the wrong business.

When I was an apprentice at pattern-making, I spent much time in the foundry, and remember every shop having its mill for grinding up the coal for facing. In those days the new sand was brought into the foundry daily, and made up into pig beds, for the use of the molders in the various parts of the shop to pour in the spill iron. Today they pour it on the damp floor, and the foundry looks like being struck by a cyclone. The various items in the supply lines were bought from the several makers and many devices are as old as the hills. I remember being in an old foundry in York, Pa., and saw there a power sand sifter which was so old that the man driving it thought it came from the ark. Today all these things are handled by the supply house, and it is much better so, for there is now a chance for continual improvement.

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Standard and Systematic Methods for Making Beds.

BY THOS. D. WEST, SHARPSVILLE, PA.

The importance of having standard methods of making green sand beds was first brought out by the writer at the meeting of the New England Foundrymen's Association, in November, 1903, in a paper entitled, "The bottom of a green sand mold." This paper was of such interest to that society that a committee of three was appointed to bring the matter before this convention for some definite action of permanent value to the industry.

In order that I may aid this committee by presenting systems for consideration as standards, I have thought that a treatise showing what my investigations and experience could offer, might not only prove of value to our members, but also impress the general trade with the importance of standards for making beds, at the same time showing the great extent of the subject which can and should be thoroughly systematized.

When it is stated that there are over thirty systematic ways of making beds, to say nothing of the many slip-shod methods that are followed, the average experienced molder who knows but three or four ways of doing such work must concede that there is something yet to learn in the business of making perfect castings.

It is a well known fact that there are few molders who will make beds for the same class of work in the same way. It is also well known that there are improper as well as proper methods followed, the former causing many defective castings, and often heavy losses which might have been avoided had there been standard and systematic plans to follow.

Kind of Beds Used.

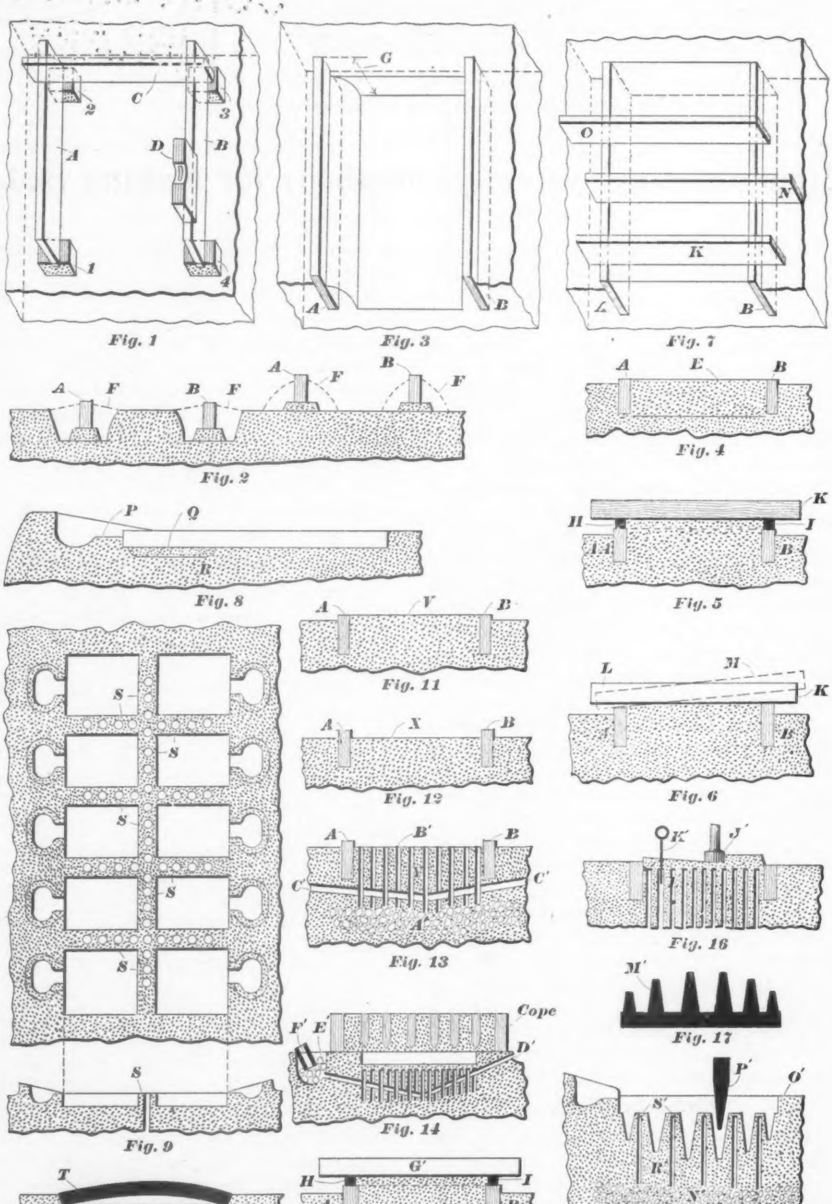
There are two kinds of beds used in a large number of foundries. Generally speaking, one is called a *soft* bed, and the other a *hard* bed. The former is used for making "open sand castings," or without a cope, while the latter, as a rule, must be the bottom of a closed mold.

In making either soft or hard beds, means must be provided to give any form that may be desired. As a rule a bed has a plane level surface.

Should a bed be used for open sand castings it is necessary that it be perfectly level, otherwise the castings will be thicker on one side or end than on another. By placing a cope over a bed conditions may prevail which force metal to run up hill, and hence castings of even thickness can be obtained on beds made out of level, which it would be impossible to make on "open sand" beds. Hence the importance of correct work in leveling beds for open sand castings.

Leveling Straight Edges to Make a Bed.

The first requisite in making a true bed is a true level. Then we require three straight edges as seen in Fig. 1, two of which, A and B, are true on one edge, while the third, at C, is true on both edges, and each parallel with the other. In starting to level up the straight edges to make a level bed, it may be necessary to set them in the floor as on the left, or on top as on the right of Fig. 2. In any case A and B should have their ends resting on sand mounds, as at Nos. 1, 2, 3 and 4, in order that either end may be pressed down to obtain a true level, without danger of rocking, as would be the case if the sand were under the middle. The first to be leveled is A, after which B is set on the sand mounds 3 and 4, as near to the level of A as the eye can judge. This done, C is set on the top edge of A and B near one end, and then brought to a level by either building up more sand under the end at No. 3, or by pressing it down into the mound. The end at No. 3 agreeing with the level of the end at No. 2, the level D is then placed as shown, and the end of B at No. 4 brought to a level of Nos. 1, 2, and 3. Sand is now filled in the vacant space between the mounds under the straight edges and tucked up with the fingers to get it all as solid as this can make it. Should the straight edges be in the ground or above it, as on the right and left of Fig. 2, sand is then filled in on the



METHODS OF MAKING BEDS.

sides and rammed to be in keeping with the form shown by the dotted lines F. In doing all this, after first leveling the straight edges, there is a liability of getting them out of true, and hence to be assured that everything is correct, the straight edges are releveled, and parts found high are pressed down by knocking on a flat piece of wood placed on the upper side of the straight edge, to preserve it from abuse. Some may lift the low end up and try to shove sand under it instead of knocking the high side down, but this will not leave as solid a bed under the straight edge as knocking them down. This must be done in such a manner that the bedded straight edges A and B will not rock. This is avoided by pounding down the middle with the last blows.

Making Soft Beds.

Soft beds are generally labor savers. Their use obviates ramming and venting. There are few, if any, castings made on soft beds that cannot be made on hard ones, were these but thoroughly vented. In making a hard bed a rammer or the feet are used, whereas with a soft bed only the palm of the hands, a flat body, or the edge of a straight edge is employed, the latter being the one most often used. The hardness obtained is all on the surface of the bed, while a hard bed is generally softest on its face, the underlying material being more solid and often as hard as can be made by ramming.

The hardness of the face of a soft bed is generally regulated by the pressure of the palms of the hands, flat board, etc., or the thickness of what is called "knock-down pieces," which range from ⅛ inch to ⅝ inch as the circumstances may require it. A scheme of the sizes being seen in table 1.

After leveling the straight edges as seen in Fig. 1, in commencing a bed that is below the floor level, as on the left of Fig. 2, we have a view something like that seen in Fig. 3, which shows sand dug out between the straight edges A and B for the required depth, as at G. This space is now all filled in with nicely tempered or ½ inch riddled sand and struck off to appear like E, Fig. 4, being careful that the sand is placed in loosely without pressing it down in any manner. Sand is now riddled on through a No. 4 sieve evenly all over the surface of the bed, to a depth of ¼ inch to ¾ inch, as may be required. Or the sand having been riddled on the floor is shoveled on to such a height as may be found practicable. This done, "knock-down" pieces H and I are placed on the straight edge A and B, as seen in Fig. 5, after which a straight edge is placed on top of H and I as shown at K, and a man at each side holding the straight edge in one hand and the knock-down pieces in the other, together pull both along the top of A and B, carrying off the surplus sand that projects above the level of the tops of H and I. It may require two or three strike-off operations to obtain a full smooth surface, as the first pulling drags the sand, and often leaves unfilled sections in the bed that must be filled in with sieved or riddled sand, and which (to become even with the other portions) must be struck off with the strike, as suggested above.

The surface having been struck off, it remains to be pounded down to the level of the tops of A and B. This operation is illustrated by Fig. 6, and is done by first removing H and I, and then with a man at each end of K alternately lifting up one end 3 inches to 4 inches, and pressing it down while the other is held stationary; the dotted line, showing how the now depressed end at L will be lifted, as at M, in its turn to pound down the raised sand. As each end is lifted, it is carried on an angle as far as it can go before its end would be off the straight edge to let it be pressed below the level of the bed.

In selecting knock-down straight edges, they should be taken sufficiently stiff or deep to keep them from bowing in the center while being used. If this occurs it causes the center of the bed to be higher than the outer portions, and hence not be a level bed unless carefully struck off. The depth of the knock-down straight edge should not be under 4 inches for beds under 24 inches wide and for every foot increase in width, the depth of the straight edge is increased 1 inch. For a bed ten feet wide, this would call for the knock-down straight edge 12 inches deep. In thickness they range from 1 inch to 1½ inches, and as the depth increases so should the thickness.

Granting that a knock-down straight edge leaves a bed true in its width, it may even with the best of care leave some irregularities or ridges on its face due to the action of one knock not covering another sufficiently to prevent marks being left on the face of the bed. There is much work for which sleeking over these marks with a trowel will allow a bed to be used without further striking off; but where the quality of the work demands the most perfect bed tnat can be produced, it is necessary to strike it off after knocking it

down. In doing this, the strike is given a forward see-saw motion, one that causes the strike K to be pulled on a slight angle to one side of the bed as at N and then back to the other as at O, Fig. 7. Care should be taken to always have every movement a forward one, for should the strike be allowed to go backward at any time, this would cause the bed at that point to be marked, or to have a slight depression that did not exist in other portions.

The objection to merely pulling the strike K in a straight and forward direction, is the great liability to tear up, or make a rough face on the bed, which could be the cause of scabs or rough castings. After the bed has been all struck off it may be a little rough, where coarse sands are used. In such cases a thin covering of sand, not more than 1-16 inch thick can be sieved or spread over one end of the bed, and then by starting at this end, it can be see-sawed off for a final finish.

Where the knock-down pieces have been over ¼ inch thick, the trowel can often be used to give a good finish to the bed surface, and this may often be assisted by first spreading on with the hand a very slight scattering of fine sieved sand over the surface of the bed. With knock-down pieces thinner than ¼ inch the surface of the bed is so soft that there is much danger in the sleeking operation depressing it at spots, and thereby causing an uneven surface on the mold's face of the casting.

Regarding the size of the knock-down pieces to be used for a given piece of work, no rigid rule can be given. This depends largely upon the character of the castings to be made and the kind of sand used. For the same cross-sections, one having a coarse grade of sand might use a ½ inch knock-down piece whereas with fine sand might require ¼ in or ⅛ inch pieces only.

By using the thickest knock-down pieces for coarse grades of sand, and the thinnest for the finer varieties, other conditions being equal, the depths for soft beds given in table 1 could be adopted for making open sand castings ranging from ½ inch to 3 inches in thickness. The thinner the castings the thinner the knock-down pieces to be used, as a rule.

It is to be understood that by using the depths of beds or loose sand given in table 1, no venting of any character is required, but where it is practical to lay ¼ inch vent rods 3 inches to 4 inches apart on the solid ground to reach under the entire bed and put 1 inch to 2 inches of sand over them before shoveling loose sand to fill in the bed, the depth given in table 1 could be decreased 25 percent for the smallest bed, to 40 percent for the largest one. Some may drive the vents sufficiently deep under the surface with one vent wire after a bed is made, to not disturb its face, thinking to thereby save the labor of digging out deep beds, or laying down a large number of ¼ inch vent rods as per the above. This, however, is not to be recommended, as there is much danger of the soft sand filling up the vent holes when the wire is withdrawn, and thereby shutting off the intended escape of gases and causing the metal to bubble and boil, with consequent poor castings.

The greatest difficulty in using soft beds lies in the liability of the metal leaving the runner at P to cut and wash away the soft sand fronting it at Q, Fig. 8. In beds above 4 feet square it is generally a good plan to cut out a portion of the bed fronting the runner P for a depth of about 2 inches above R, and then fill this up with all new, or facing sand, packed down with the palm of the hand to the consistency of a hard bed. After this the part in question is vented with an ⅛ inch wire downward and below with a ¼ inch wire to catch their gases. The top of the cut-out portion R is then struck off and finished to correspond with the adjoining level. This allows the portion fronting the runner to stand very rough usage when pouring large plates, and gives them as smooth a surface at this point as is obtained over the general face of an open sand casting. Where this method is adopted very coarse grades of sand can be used for the balance of the bed other than that fronting the runner, which is very desirable for making large plates.

It often occurs that a molder may wish to make a number of fair sized plates on a floor area that will necessitate having a partition of but 3 inches or 4 inches between edges of the plates, as seen at S, Fig. 9. In such cases it is generally advisable to run down a ¼ inch to ⅜ inch vent wire between edges, as seen by the holes shown, because if this is not done, the plates poured last may draw the gases from some that have been poured and thereby raise the center body of the plate casting while in a semi-molten state, making it appear something like the one seen at T, Fig. 10. The above work of down-venting may be avoided by having extra depths of loose sand under the face. Nevertheless, there are cases

where it is well to follow the above practice of venting the partitions between plates.

The temper of any sand forming the face of the plate mold, be it open or closed, should be worked as dry as practical. In making plates over 1½ inches thick it may often be necessary to use a facing sand in order to assist the dusted blacking, or graphite, to peel them. In using any facing sand over the general bed it is put on the thickness of the knock-down pieces H and I, a plan which insures its being of even thickness all over the bed. As a rule facing sand is not used on open sand plates unless they are over 2 inches thick. Blacking, graphite, soap-stone, or lime, dusted over the face of any all-common sand beds will generally peel entirely, when under 2 inches thick, unless it be the body fronting the runner, where a little facing sand can be used, as shown at Q, Fig. 8, to help the blacking, etc., to peel the casting. Then again, a good coat of these materials fronting the runner, may often answer the purpose of facing sand at this point, providing that there is not too large a body of metal washing over it. The safest plan, however, is to use facing sand as described above, and shown at Q, Fig. 8, in connection with the blacking, etc.

The metal to run open sand castings should be very fluid and with good life, as dull, sluggish metal cannot give good open sand plates. Because plates may be made in open sand, there is no reason why one can be careless or slovenly about it. It is as creditable to make good open sand work as the closed, and in many cases more so.

Method of Testing the Hardness of Beds.

In obtaining the weight necessary to penetrate beds ½ inch, as given in the above tables, the hardness tester exhibited by the writer before the New England Foundrymen's Association, Nov. 11, 1903, was used. This device was illustrated in the following journals: The Iron Trade Review, Nov. 12, 1903; American Machinist, Dec. 3, 1903; Journal of this Association, January, 1904; The Foundry, January, 1904; London Engineering, Jan. 8, 1904, as well as other publications.

In making the hardness tests given in table 1, a nowel 4 inches deep, 12 inches square was filled with loose sand passed through a No. 8 sieve, and struck off with knock-down pieces H and I varying from ⅛ inch to ⅝ inch in thickness, as seen by the bed numbers 1 to 9, in table 1.

After each bed of soft sand was struck off and knocked down, the hardness tester was placed on the bed and six impressions made, the average of which was taken as the weight given in the third column of table 1.

The hardness tests for tables 2 to 4, were made in the same 4 by 12 inch nowel, as above, the only difference being that the sand was rammed hard up to 1 inch, ¾ inch and ½ inch, respectively, of the top edge. Sand was then passed through a No. 8 sieve, shoveled on, and struck off with the respective knock-down pieces. All of which is shown in tables 2 to 4.

By using care to pull steady at an even speed, one test will agree remarkably close with another, especially when all the sand is used sieved. The tests given show the relative hardness obtained under similar treatment with identical conditions, and what we would expect from the use of different thicknesses of knock-down pieces in general practice.

The only other matter, aside from the above precautions that can cause any noticeable difference in taking tests as given in tables 1 to 4, in different shops, is a variation in the dampness or temper of the sand used. This difference, at the worst, is very slight, and not sufficient to affect the tests to any extent that would be harmful. The system can be made to given an intelligent control on the part of the manager or molder in obtaining any desired degree of hardness in molds never possible heretofore. Should it be desired to omit the hardness tester, this will not impair the value of the systematic methods that are presented here for beds of different character.

How to Designate Kinds of Beds.

In designating the kind of bed wanted, in the case of soft or semi-hard beds, one will refer to both the bed number and the initial. With soft beds, instead of citing No. 1, A, it might be No. 1, D, or any other of the initials of table 1, for the reason that the depth of sand is not always to have its face pounded down with the same thickness of knock-down pieces H and I, as the area of the bed generally regulates its depth.

In designating semi-hard beds treated at the close of this paper, one will in citing the number of the bed which represents the thickness of the knock-down pieces, also give the initial that represents the depth and the area of the bed desired, all of which is given in table 1.

In the case of the hard beds, tables 2 and 4, treated in the following pages, different conditions prevail than with the above beds, and these are such that it is only necessary to call

West's System for Making Soft and Hard Beds.

TABLE 1. SOFT BEDS FOR MAKING OPEN MOLD CASTINGS.

Bed No.	Thickness of knock-down pieces H. & I.	Weight to penetrate bed ½-inch	Initial with equivalent in inches to designate depth of tempered sand in a bed.		Initial with equivalent to designate area of a bed.
1	⅛-in.	4 oz.	A— 5 in.	J—14 in.	S— 2 ft. sq.
2	$\frac{3}{16}$ "	6 "	B— 6 "	K—15 "	T— 3 "
3	¼ "	9 "	C— 7 "	L—16 "	U— 4 "
4	$\frac{5}{16}$ "	12 "	D— 8 "	M—17 "	V— 5 "
5	⅜ "	15 "	E— 9 "	N—18 "	W— 6 "
6	$\frac{7}{16}$ "	1 lb. 2 "	F—10 "	O—19 "	X— 7 "
7	½ "	1 " 5 "	G—11 "	P—20 "	Y— 8 "
8	$\frac{9}{16}$ "	1 " 9 "	H—12 "	Q—21 "	Z— 9 "
9	⅝ "	1 " 13 "	I—13 "	R—22 "	AA—10 "

TABLE 2. HARD BEDS FOR MAKING OPEN MOLD CASTINGS.

Bed No.	Thickness of knock-down face X.	Thickness of knock-down pieces H. & I.	Weight to penetrate bed ½ inch.	Thickness of castings that can be made on the respective beds.
10	1 in.	⅛ in.	8 oz.	½ in.
11	1 "	$\frac{3}{16}$ "	1 lb. 0 "	¾ "
12	1 "	¼ "	1 lb. 8 "	1 "
13	1 "	$\frac{5}{16}$ "	2 lb. 0 "	1¼ "
14	1 "	⅜ "	2 lb. 9 "	1½ "
15	1 "	$\frac{7}{16}$ "	3 lb. 3 "	1¾ "
16	1 "	½ "	3 lb. 15 "	2 to 6 "

TABLE 3. HARD BEDS FOR MAKING CLOSED MOLD CASTINGS.

Bed No.	Thickness of knock-down face X.	Thickness of knock-down pieces H and I.	Weight to penetrate bed ½ inch.	Thickness of castings that can be made on the respective beds.
17	¾ in.	⅛ in.	1 lb. 6 oz.	½ in.
18	¾ "	$\frac{3}{16}$ "	1 lb. 14 oz.	¾ "
19	¾ "	¼ "	2 lbs. 7 oz.	1 "
20	¾ "	$\frac{5}{16}$ "	3 lbs. 3 oz.	1¼ "
21	¾ "	⅜ "	4 lbs. 6 oz.	1½ "
22	¾ "	$\frac{7}{16}$ "	6 lbs. 4 oz.	1¾ "
23	¾ "	½ "	8 lbs. 2 oz.	2 to 6 in.

TABLE 4. HARD BEDS FOR MAKING CLOSED MOLD CASTINGS.

Bed No.	Thickness of knock-down face X.	Thickness of knock-down pieces H and I.	Weight to penetrate bed ½ inch.	Thickness of castings that can be made on the respective beds.
24	½ in.	⅛ in.	4 lbs. 4 oz.	½ in.
25	½ "	$\frac{3}{16}$ "	5 lbs. 0 oz.	¾ "
26	½ "	¼ "	6 lbs. 0 oz.	1 "
27	½ "	$\frac{5}{16}$ "	7 lbs. 4 oz.	1¼ "
28	½ "	⅜ "	9 lbs. 0 oz.	1½ "
29	½ "	$\frac{7}{16}$ "	10 lbs. 8 oz.	1¾ "
30	½ "	½ "	12 lbs. 6 oz.	2 to 6 in.

for the number of the bed to designate just what is desired.

While there are thirty different kinds of beds in the four tables given, they all differ sufficiently to cause the skilled and intelligent molder to make a selection, and thus get the one that is best every time he is called upon to make a different job. This will undoubtedly put aside the impression existing in the minds of many, that any old thing will do in the foundry.

Making Hard Beds.

There is less uniformity in the practice of making hard than soft beds, for this reason there is special need of standard or systematic methods to make them. Hard beds are necessary where a mold is covered with a cope, as this creates a heavy pressure not met with on the face of the open sand cast mold. Were one to pour an open sand plate made bed with a cope on it, the casting would come out much thicker than its pattern, especially in the center body, which means an untrue casting.

The conditions demanding certain degrees of hardness in the face and under body of a hard bed will depend upon the speed of covering a bed with a body of metal, or pouring, and the pressure that will be brought upon it when the mold is filled with metal. As a rule, the face of a hard bed should be much softer than the under body. It is only in cases where the bed is covered rapidlv and a heavy pressure brought upon it, say inside of 5 to 7 seconds, that it is safe to have the face of the bed so hard that it requires a pull of 20 pounds to penetrate it ½ inch. There is work that will require even a harder face or higher pull than this.

By having a system we can regulate the question of hardness to obtain any degree desired. A system that could be adopted universally is illustrated in Figs. 11 to 15. Here at A and B, straight edges are leveled on the plan shown by Figs 1 and 2, for making soft beds. This done, sand is filled in and rammed up solidly to the top, as seen at V, Fig. 11, after which a strike is used to lower the rammed body below the level of the straight edge to a depth of ½ inch to 1 inch, as may be desired, to appear as at X, Fig. 12. Up to this level the degree of hardness desired is regulated by the power upon the rammer, and may be rammed so hard that it is difficult to penetrate it with a vent wire. In no case, however, must venting be omitted in this body, and as a rule tne harder the ramming, the closer and more the venting required.

In venting the body Y is shown between the straight edges A and B, Fig. 13, the vent wire is driven down to the cinder bed as at A′. These vents should not be over 1½ inches apart, and make a vented bed appear something like the surface at B′. Where cinder beds are not employed as in A′ then it becomes necessary to connect the down vents B′ with under vents as at C′. These under vents may not be driven until after the bed is completed, straight edges pulled out, and the cope rammed up ready for lifting off. In many cases these under vents may be brought up to the joint of the mold as at D, Fig. 14. Then again, a recess may be made in the floor and filled up with fine coke as at E′. After this the recess and coke are covered up with sand and the vent brought to the surface with gates as at F′, or vents driven from the floor's level down to the coke.

Returning to the subject of compression or ramming of the sand, we are carried back to Figs. 12 and 13. Here the distance between the face at X and B′ respectively, and the top of the straight edges A and B, is to be made or rammed in a manner to carry the molten metal without bubbling or boiling. The bed having been vented as at B′, Fig. 13, the first operation is to close up the top of the vent holes by rubbing the palm of the hand over them. This done, sand (which may be a facing sand in the case of heavy plates or special light work) is shoveled on, to project ¼ inch to ¾ inch above the top of the straight edges and then struck off with knock-down pieces H and I and a strike G′, as at Fig. 15, after the manner given for making the face of soft beds. The thickness of the knock-down pieces H and I, and the depth of the rammed face, which is the thickness of sand ranging from the bottom at X to the top of the straight edges A and B, Fig. 12, is what regulates the hardness of the face of the bed. The less the depth at X the greater the thickness of the knock-down pieces, the harder the body forming the face of the bed.

Hard beds are used for open sand plates as well as covered ones. This is found advantageous in the case of plates, etc., having lugs, flanges, or projections on them that would require solid bodies of sand around them, and more or less finishing of these parts of the mold with tools. In using hard beds for open sand castings, those of table 3 having the thickness of the knock-down face but ¾ inch are

often preferable to those of table 2, as this brings the vented face up nearer to the face of the mold and gives a bed that is not as hard as those of table 4. A point must be specially remembered in this connection, and that is the necessity of closely venting the whole body under the knock-down face, and also the importance of avoiding the use of very fine grades of sand for this surface. Where shops have trouble with fine sands, bank, shore, or other sharp sand could be mixed with the fine molding sand. This matter can also oftentimes be helped by using thinner knock-down pieces for the respective thickness of casting than shown in the last column of table 3, as for example in making a plate $1\frac{1}{2}$ inches thick, the 3-16 inch instead of the $\frac{3}{8}$-inch knock-down pieces could often be used, and in designating the bed number, one would merely order No. 18 instead of No. 21 to be used.

It is not expected that by presenting all this material, that it will avoid the necessity of using brains. Far from it. What is given is intended to be a help, and by following the principles advanced, much benefit will result.

Aside from the methods shown in Figs. 11 to 15, and the three tables for making hard beds, we have the butted face bed. This class of beds is made by first ramming up to the level of the top of the straight edges A and B as at V, Fig. 11, and then striking it down from $\frac{1}{2}$ inch to 1 inch, according to the depth of good common or facing sand required, as at X, Fig. 12, after which the body is closely vented, as at B′, Fig. 13. This all done, the top of the vent holes are all closed with the palm of the hand and riddled sand shoveled on and struck off as at G′, Fig. 15. The depth of the pieces H and I, Fig. 15, should be fully $1\frac{1}{4}$ times that of the struck out depth X, Fig. 12. After the common, or facing sand, is struck off, the butt end of the rammer is used as at J′, Fig. 16, in a way to ram down the face in a regular even manner to obtain any degree of hardness desired, such as may range from requiring beds as hard as Nos. 26 to 30, seen in table 4, and which in the case of very hard beds may call for a pull of 25 pounds. In butt ramming such a surface, care must be exercised not to miss a spot and to avoid going over the same place twice. The butting all completed, an $\frac{1}{8}$ inch vent wire K′ is used all over the face to drive vent holes into the main body 4 inches to 6 inches deep, so as to have the face gases find relief through the body vents which will connect with the cinder bed A′ or under vents C′ as at Fig. 13. It is to be understood that one is not expected to have K′, Fig. 16, find a vent hole every time it is driven down as at L′. If K′ never struck an under vent L′, the gases will be able to escape to the under vents L by reason of the porosity of the sand, which in its body between the under vents, if these are not over $1\frac{1}{2}$ inches apart, will give good freedom for the escape of surface gases.

The surface venting finished, the face of the butted bed is struck off smooth in a see-saw manner, after which sand is sieved or scattered on sparsely over the surface with the hand, and then rubbed down with a smooth hard wood block about 2 inches thick and about 3 by 8 inches. This surface is in turn sleeked over with the trowel, and the bed is finished.

In venting butted faces or beds, some will dispense with the use of the second vent wire K′, and vent direct from the butted face, down to a cinder bed A′, or under vent C′, with a large vent wire, and then stop up the top of the large holes left with the point of the finger. This is objectionable for the reason that finger poking can close the tops too far below the surface and should any be missed or not closed tightly, the melted metal could escape to the cinder bed under the vents, thereby causing boiling, scabs, or a "blow-up."

Making Semi-Hard Beds for Prickered Plates.

The most difficult class of work for which to construct beds, is the making of plates used by the molder to carry hanging bodies of sand or loam. These call for prickers which in some cases are very long. At M′, Fig. 17, is seen a long prickered plate, and to cast this successfully, if long, requires careful manipulation to prevent the center of the bed from lifting or blowing when being cast. The difficulty lies first in the necessity of having the bed soft enough to admit of driving long prickers into the sand and at the same time not so soft that the pressure at the bottom of the prickers, when pouring the plate, can strain sufficiently at the bottom to lift up part or the whole center body of the bed. Second, in the excess of gases created by reason of the long prickers often more than doubling the area in which to create gases than would come from a flat plate. Many molders have failed to consider this point, and when pouring the casting, are surprised at finding what metal did not go into bodies of scrap went skyward.

In making long prickered plates it is generally the safest plan to place a cinder bed under the mold, as at N′, Fig. 18. After the cinder

bed is in place, nicely tempered sand, dry as can be worked, and riddled through a ½ inch or No. 2 riddle, is shoveled into the hole in about 4 inch courses at a time, until within about 6 inches of the face. These courses are pressed down with the palm of the hands, or by securing boards about 6 by 12 inches to the feet and walking over the soft sand, as one would with snow shoes on soft snow. To tramp about without such boards would make the bed too hard. The last 5 inches of the depth of the bed is made after the system of making soft beds and which includes selecting the number of knock-down pieces, also the initials to designate the depth and area of beds, as given in table 1.

The bed made and side O', Fig. 16, formed, the next operation is knocking down the pricker patterns P', of which there should be four or six, so that the knocking down of one pattern cannot burst the sand through to any holes or prickers that have been formed by the withdrawal of a pattern. When all of the pricker patterns are in the bed, the space between them is closely vented with an ⅛ in vent wire from the face of the bed down to the cinders, as at R', care being taken to avoid placing any vents so near to a pricker pattern as to permit the metal to burst through to them and thereby run into the cylinders, filling the space for release of gases. A few of these leaks can make conditions so bad that it would have been better to have had no venting or provision to carry off the gases made in the beds at all. In venting between the prickers the tops of the vents will require to be stopped up by pressure of the finger, and after filling the depression with sand, the body is sleeked over with the trowel. In doing this part of the work, care should be taken to close the top of every vent hole and also not to make the surface any harder than the knock-down pieces used would leave it.

A point, a little aside from the subject of this paper, but well to refer to here, is the danger of metal cutting in front of the runner, especially in large prickered plates. To prevent this the surface fronting the runner is best made entirely of new or facing sand, after the plan at Q, Fig. 8, and as an extra precaution should be surface nailed. Then again, it is best to make the runner where it passes the metal to the mold fairly broad, as a narrow runner at this point confines all the cutting action of the metal within a narrow space, thereby giving a chance for injury to come quicker than would otherwise be the case.

THE FOUNDRY APPRENTICE AS SEEN IN ONE SHOP.

BY CHAS. H. THOMAS, NEWARK, N. J.

This is becoming a serious subject. Where are the molders of the future to come from? In our larger cities it seems almost impossible to get good material for the purpose. Recently we advertised for two apprentices in one of our daily papers. We received one reply. We arranged for an interview, and the applicant put in his appearance. He was a likely young man of 17. His father was a saloon keeper, and the boy was so desirous of getting out of a business so disagreeable that he was anxious to start the next day to learn the foundry business in all its details.

I informed him that no matter what the nature of a business may be, it should be thoroughly investigated and thought over, before a final decision was reached. I invited him to visit the foundry the next day. I gave him full information as to the duties, the nature of the different classes of work, etc., so that he would have the situation before him, as it really was. His wages were to be 80 cents a day the first six months, 90 cents the second six, and so on until the end of his indenture. Moreover, should he show adaptability, the raise would be higher, depending upon his output and the quality of the work he turned out. He appeared pleased and desired to start the next day—but, alas—that tomorrow never came.

After leaving, he had evidently digested more thoroughly what I had told him. Four years looked a long way ahead. He never started, and will probably graduate as a crap-shooter, and eventually become a Tammany leader or perhaps worse. We have had four boys since, three of them only stayed a day or two, and the fourth, with Teutonic persistence, is still here and doing well, with every promise of becoming a first-class mechanic.

Why is it that we cannot keep apprentices? We pay them all holidays and overtime. We make life pleasant and agreeable, and give better pay for better work, "and still some are not happy." Is it the trend of the times, or not? Who can say? But we do know that the boy of today wants more money for doing nothing and spoiling a lot of work than did the boy of a quarter of a century ago. Because the ways of spending money are today more numerous, dissipation more common and deplorable, that is no reason why the boy of

today should be worth more than formerly. Cigarette smoking, immorality, emulation of the gilded youth who belongs in the reform school, and other pernicious habits, sap the energies of the average young man who presents himself at the foundry and render him unfit for the labor required there.

Where, then, are we to recruit the molders of the future from? The American city boy, with but few exceptions, shuns all labor meaning exertion. We must look to the country, or to the influx of foreign youths with an inborn desire to be independent and be masters of a trade.

As we all know, the foundry trade is one requiring more than the mere pounding of sand. The boy from the country may or may not make a good molder, but he is sure to be a jack-of-all-trades, and as such he has a good constructive ability, becomes a good mechanic, and if not too smart, will become valuable to his employer, only to some day become an employer himself.

The youth who leaves his native country to prosper here has a hard row to hoe, being handicapped by lack of knowledge of the language and ways of this country. But it is a good school for him, and with his usually very frugal habits he lays by a little all the time for a rainy day, and by the time he is Americanized, he has a trade and some coin of the realm.

If we are asking ourselves as a nation—Whither are we drifting? So does the foundryman ask himself—Where are not only our future but even the present generation of good molders to come from? Where do they all go to? We never see many old men working on the floor, and very seldom hear of a molder dying. What becomes of them? Except in times of depression, there is also a scarcity of good molders.

It is quite evident that foundrymen must recruit their apprentices from the available surrounding material, and inducements must be offered to them, of such a nature that they will have their attention riveted, and strive to reach the goal as rapidly as possible. The foreman must take the boy into his confidence and not allow him to go to a molder for his information at all, or allow the molders to make suggestions to him. I have tried this method with conspicuous success.

I tell the boy what facing to use, where to set his sprues and risers, if any; how to cut his gates; and then leave him alone until he gets stuck and asks for aid. Then I take him all through the part of the work he has done right, up to the point where his difficulty commenced, make several suggestions as to the different ways in which the job can be secured, and ask him which would seem to him to be the quickest and best. If he does not select the best way, I suggest it to him. If there are more than one off the pattern, and there are several ways to do the job, I advise him to try each a different way, and let me know the result. When he makes his report he has had time to think, and generally has selected the easiest way suggested. With a smile, he says that it seems twice as easy when he knows how and that he can make the next one in very much less time, invariably doing so, if not interfered with by the molders.

I praise his castings when they are turned out clean and sound, and when a bad one is made, the boy and I hold a post-mortem examination on it, decide upon the fault, and look for the remedy. These are things that boy will never forget. In this way I try to have the good and bad results leave a permanent impression.

As the boy advances, we give him a chance to make extra time, and it is surprising to note the special energy an hour or two a day put in by the boy when a job is given him which will keep his mind occupied and hustling. We make it a practice of paying our men for what they do in the way of good work. We never allow a boy to close a poorly finished mold. He must learn to make a neat, clean mold, before he can attain speed. He is told that a neat, clean workman can always be picked out by his personal appearance, and the condition of his floor and tools.

Just as soon as the boy begins to show an improvement, we start him ahead by giving him better and better work, not forgetting the little raise from time to time with the extra accompanying it, the idea being to keep the boy satisfied. It is surprising to see how they will vie with each other to get out the best job in the shortest time. This may sound like a fairy tale, but can be readily verified by personal inspection any day.

Now for the very important matter of the apprentice ratio. The Molders' Union allows one for the shop and one for every eight molders. In other words, that which was good enough forty years ago, but is obsolete now. The foundrymen are wanting one to six, but this like other modern ideas the molders will not give. Nevertheless it is a question for concerted action by both parties, and the near-

er the apprentice ratio is brought to one to five the better, even if the apprentice be adjudged proficient in one or more branches of the trade only. If the ratio is not increased, and the trade itself made more attractive to the young man, the scarcity of good molders will soon become a calamity.

While we cannot have Brussels carpets in the foundry, we can clean up at least once a week, and thus teach boys and men the value of being systematical. Start the boy with a trial of two months, and if in that time he does not show his adaptability as a mechanic, he never will. We do an act of kindness in advising him to make an effort elsewhere. On the other hand, when we find a boy who by industry and energy forges ahead, and who desires to learn, we do him a gross injustice to keep him on one class of work because we may happen to make more money out of him that way. The apprentice should be given the best work in the shop, as soon as he shows that he is able to tackle it. We contract to teach the boy a trade. If he is bright, push him along. If he is dull drop him, as he will only become another candidate for the minimum wage. What we want is maximum days' work, with maximum days' pay, and none of the other. Only then will the laborer be worthy of his hire.

SPECIFICATIONS—AND WHAT THEY MEAN TO THE FOUNDRYMAN.

BY DAVID REID, COLUMBUS, O.

For the many years past the foundry had had the notoriety in the mechanical world of not being able to conform closely to definite requirements of strength in the product turned out. Engineers and designers had to therefore make very liberal allowances in selecting their factors of safety.

Competition and the advance of knowledge is compelling us to discard the old rule-of-thumb methods, and look more closely into the ways by which given requirements may be fulfilled. Specifications, the things that are always seen in other industries, are now becoming more strongly pushed in ours, too fast perhaps for some of us, but nevertheless they are coming and will stay.

The average foundryman makes his first and greatest mistake when given drawings and specifications to figure on, by simply glancing over those specifications, tossing them into the corner, and then devoting hours and days in scheming how high to make his price, and how low to cut the costs, so that the job may be secured and yet be profitable. If the terms of the specifications define the material as Cast Iron No. 1 with a tensile strength of 23,000 per sq. in.; or No. 2, to be high grade Cast Iron or Gun Iron, to be made of charcoal metal, in the air furnace, or other process giving a product with a tensile strength of not less than 28,000 lbs. per sq. in., with an elongation of 0.25 percent before rupture, while under strain. If he has these things to meet, he often passes them from his mind with the feeling that good commercial work will cover this all right, takes the contract, only to have his eyes opened, and his credit and bank account impaired, on account of his inability to carry out the specifications as agreed.

The writer has had a number of instances of this kind drawn to his attention during the last six months, and is presenting this matter with the idea of showing that specifications are being constantly drawn up, not for the purpose only of getting good commercial products, but to obtain something far superior to every day castings.

The specifications for the No. 2 cast iron mentioned above, which are those of the Ordnance Department, have been recently made more stringent for a special contract I was engaged upon, and are as follows:

Material to contain Silicon 1.25 to 1.35, Sulphur not over 0.12, Phosphorus not over 0.45, Manganese 0.65 to 0.75. The tensile strength 30,000 to 35,000 per sq. in. Elongation before rupture 0.25 per cent.

To the credit of the American Foundrymen's Association, and the Cast Iron Committee of the American Society for testing Materials, be is said that we were in position to carry out such severe specifications, for their investigations have enabled us to specify in turn our pig irons in such a way that the furnaces could furnish just what was wanted.

The two classes of cast iron mentioned above, while very similar as to strength, differ in that in the first case they call for charcoal iron melted in the air furnace, or a similar process giving the required elongation; and in the second, the mixture of cast iron and steel scrap, erroneously called semi-steel, is directly specified. Foundries heretofore making this No. 2 iron have always gotten the required strength by the use of steel scrap additions, but the general orders of last November, from the Ordnance Department prohibited the making of this ma-

terial, and compels the foundryman to stick to pig iron and scrap.

If great care is used this specification can be met, whether the air furnace or the cupola is used. I have had results which averaged 30,000 lbs. with greater elongation than required, by using charcoal irons with silicon 1.10 sulphur 0.065 to 0.075, phosphorus 0.30, manganese 1.15, and the total carbon from 3.00 to 3.50. The best scrap was used, and ran about 1.65 in silicon.

In the so-called semi-steel specifications we used a Southern iron in connection with the charcoal iron, and 40 per cent of clean steel scrap. The results were highly satisfactory.

While these cases are no doubt special, and high grade material is required, they re-call the words of Dr. Dudley, in his address on "The Making of Specifications," delivered before the American Society for Testing Materials last year. He speaks of the fault characteristic of many specifications, being the effort on the part of the one drawing them up to make it a place to show how much he knows, putting in too many restrictions, and making the document too severe.

While heartily in favor of, and preferring to work to specifications, the writer believes that the foundry industry has not yet reached the point, where engineers can give full sway to their knowledge and imagination, too often the latter, in drawing up specifications for castings. The efforts of the American Society for Testing Materials, of which this Association is a component part, to make their specifications for pig iron, cast iron, and a variety of classes of finished castings, the standard for the whole world, is therefore to be commended and should have the full support of every member of our Association.

THE VALUE OF SYSTEM IN THE FOUNDRY.

BY JOHN C. KNOEPPEL, OSWEGO, N. Y.

To get orders into the foundry expeditiously, make and ship the castings promptly, and avoid mistakes, require a good system. System must be used in selecting men, in arranging the foundry so that you can see what is going on at a glance. System must be used in providing the men with work, and that best suited to their special capabilities. Whether molding, core-making, mixing and melting, or getting out the costs, system must be had everywhere, in order that the best results be obtained.

There should be but one person to look to for results in any department, and he should be left alone in the conduct of this work as long as he is responsible. Where this is not the case, the men soon lose confidence, and any blame for poor results is shifted about from shoulder to shoulder.

A few years ago someone wrote that few foundrymen knew their costs, and still others did not care for them. To the writer's mind this day is past, and loose methods will no longer go. To be in business at all means that profit must be made. A system of cost keeping must therefore be adopted which shows exactly where one stands all the time. The orders must also be watched very carefully and constantly followed up. The Foundry Manager must be a practical molder, who is familiar with all the details of shop work. He must have two qualifications. Skill and Character. He must be well read in the foundry literature of the day, so that he can take advantage of every point of value to his firm.

There is too much friction, occasionally, between the office and the works in carrying out the orders of the management, and hence come mistakes and bad results in the foundry. If the shop office were in closer touch with the management of the foundry proper, this would not be the case.

There should be system in the laying out of the work by the foreman. The orders and the patterns and core-boxes should be carefully compared. The patterns should be studied to see if they are right, as this is oftentimes not the case, and means unlimited trouble afterwards.

Another thing which should have careful attention is the system of ticketing the work. Blank spaces should be left to fill in the name and price, the number of pieces wanted, and the time of each piece or mold. The molder checks his own ticket as to the amount of work he has made each day. The foundry clerk keeps a record of all work under the direction of the foreman, so that the office may be constantly informed of the progress of the orders.

If the work is regular or for stock, the tickets can be filled out in the early part of the morning, and one day previous to molding. The core tickets likewise, but one day in advance of those for the molder, thus gaining time for the preparation of the cores. Where the work is large, due allowance is made, so that the cores may be ready when the mold is complete. Should special work be

wanted, the regular work stops, and the special gets the preference. For such work the order number should be cast on in a place where it will not be conspicuous, in a size to suit the casting. Thus for heavy work, a fairly large stamp, say 1 in. x 1in. x 6 in. would be right, and the legend would read ORD. 10,-027, the stamp being made of wood, and the figures are removable. This system checks a casting for shipment without any possibility for error.

On the morning after the cast, the foundry clerk collects the tickets, and consults with the cleaning room. The discount slips are duly made out and handed to the molder the day after the cast, so that there can be no misunderstanding about the matter.

The coremakers' tickets are checked up every day, at about noon, this being the best time, when all the work of the previous day has been completed. In the case of large work, the checking up is held until this is complete.

Here is a system the writer has used for the past twenty years with much success: Say, for instance, a piece of work is wanted during the day, and the pattern is sent to the foundry. To indicate the degree of urgency three marks are used: These marks take preference to regular or special work. If the casting is wanted but not immediately, one X is put on. If wanted the following day, it is marked XX, and if to be shipped the same day, XXX. The number of pieces are also put on, thus: 10—XXX, meaning that ten pieces are wanted that day. In shipping, the clerk is particular to compare with the duplicate order he has on file, so that no mistakes are made in this respect.

Now as to piece work. This is all right when the price is set so that the man can make at least the highest day rate paid. Where men work in groups, the pay should be divided, and in case of difficult and large work a defective casting should be allowed at half price, or even sometimes at full price. In this way the men will be contented and not object to the system, and this with little loss to the company. Where the castings are small, the pay should be only for good work. Wherever there is piece work in a shop, the men should not be kept waiting for flasks, cores, etc.

Patterns should be well made, and kept in good repair to facilitate the work of the molder. There should be no lack of tools and appliances, system in this respect paying very handsomely. Supplies of chaplets, gaggers, and clamps, etc., should be on hand, and the foundry kept clean. Have a set time to put on the blast, and when the men are through pouring, let them go home.

Perhaps in conclusion I should say that the foundry manager should mingle with the men as much as he can, and not hold himself aloof in his office. He should treat men as men all the time. and make this a system as much as anything else in the foundry, and the results need not be feared.

MEMORANDA ON THE METALLURGY OF CAST IRON.

BY ARCH. M. LOUDON, PORT CHESTER, N. Y.

In order to make proper mixtures for the work in hand, it is necessary to know the composition of the iron wanted. Then the proper pig irons can be selected and mixed in correct proportion with the scrap. Physical tests are just as essential to obtain the very best results as chemical analysis of the metal, and if conducted by the foreman after each day's work, he will be fully informed on the working of his shop, so far as the quality of the metal is concerned.

Taking up the several elements met with in iron, we find first carbon in its two forms, graphite and combined with iron. Two to four percent is the amount net with in ordinary pig irons. The form of the carbon present in cast iron will depend upon great or small amounts of silicon, and heavy percentages of sulphur, phosphorus, and manganese. Thus low silicon with high sulphur, high manganese, high phosphorus, will increase combined carbon, while the opposite conditions, within reasonable limits, will increase the graphite. Hence the results are iron hard, strong, brittle and high in shrinkage; or soft, tough, weak, and low in shrinkage.

Silicon is the softener and cheapener of the daily mixture. When used with care it increases the fluidity of the metal, it controls the carbon present as stated above, but can also cause a lot of trouble if used in too heavy percentages.

Sulphur is the most injurious of the elements found with iron. The temperature of the cupola should be watched with care, as the higher this is, the lower the sulphur in the castings for the same charge and coke. Occasionally it gives good results, in that it hardens the chill of the car wheel and the roll. But the bad effects are so apparent, that

we can lay much of our trouble with blow holes, high shrinkage, red shortness, etc., to it. It keeps the carbon in the combined state, and hence is very bad where soft work is wanted.

Phosphorus is a very important element. When too much of it is present, there is cold shortness to contend with, castings often cracking days after they have been made. As, however, the fluidity seems to be increased by its presence, it is of value in art work. It should never exceed 1.00 percent in the foundry, as it causes weak castings, and in cases where the iron is allowed to cool down, the upper surface of the castings are found to be all blow holes.

Manganese is also of great importance to the foundryman. Where strong, close, and hard chills are wanted, manganese must be used with judgment, as up to certain points it will be a great help in this direction. It neutralizes sulphur to a small extent, the product going into the slag. To do good work in the ladle, ferro-manganese should be finely powdered, passed through a No. 12 sieve, and stirred in well. This takes care of the oxidation present to some extent, the manganese uniting with the oxygen, and passing off into the slag. The amount to be used is about 3½ lbs. to the ton.

I will now give the average analysis required to obtain the best results for various classes of work from chilled iron to stove plate. Chilled castings can be obtained from 1/16 in. deep to solid white. A good method of finding the depth of chill given by your mixture is to take say a 6 in. diameter print, and cut it in two longitudinally, and ram up pat against an iron bar in open sand. Then pour the iron to a depth of 1½ in., the chilled face being against the iron bar. Allow to set, take out with a pair of tongs, and cool the test piece in water slowly, and break in two. You will find the chill very readily and can then know how much chill your castings will have. The composition of irons to give chilled castings from 1-16 in. chill to solid white is as follows:

	Light chill.		Solid White.
Silicon from	1.50	to	0.50
Sulphur from	0.02	to	0.09
Phosphorus from	1.50	to	0.50
Manganese from	1.50	to	0.50

Exepriment alone determines the degree of chill you will get for your work, and manganese and sulphur can be used to make this chill hard.

For large machinery castings the composition of the iron must vary according to the amount of machining to be done on them. The construction of the pattern also gives weak points to be watched. For large engine beds, a very good mixture would consist of

Silicon	2.00 %
Sulphur	0.05
Phosphorus	0.50
Manganese	0.45
Total Carbon	3.50

This would allow No. 3 foundry iron to be used and a large percentage of scrap with a soft iron introduced to get the above average analysis.

For light machinery castings the iron must be soft, tough, and close grained, as the machine work calls for high speed and the surface when finished must be smooth and bright. A good mixture for this should contain

Silicon	2.25 %
Sulphur	0.05
Phosphorus	0.65
Manganese	0.50
Total carbon	3.50 to 3.75

To secure this No. 2 plain iron is used with 50 percent scrap.

For stove plate and very small light castings which must be drilled and are exposed to sudden changes in temperature, must be soft, tough, with low shrinkage to prevent cracking and warping, the following mixture is given:

Silicon	2.75 %
Sulphur	0.04
Phosphorus	0.75
Manganese	0.40
Total Carbon	3.75 to 4.00

For this purpose the best is the cheapest, as very slight changes cause enormous losses on occasion. The mounting room and machine shop may be delayed seriously by any error in the foundry, hence the importance of good material.

THE VALUE OF CHEMISTRY IN THE FOUNDRY FROM THE FOREMAN'S STANDPOINT.

BY J. J. WILSON, DETROIT, MICH.

The value of chemistry in the foundry depends upon one's ability to apply it with care and good judgment. It is no experiment and is the only positive method of keeping the mixture uniform.

With the keen competition in the foundry business at the present day, those foundries wishing to keep in line with their most progressive competitors, will have to adopt chemistry, as no modern foundry can afford to be without it.

In foundries making any pretense of pro-

ducing work of merit, the one essential is uniform castings that will stand the service for which they are intended. In the first place, to produce first-class castings, it is necessary to know the demand that will be put upon them, so that the proper mixture may be made to produce them. With the knowledge of the contents of the raw material, this is comparatively easy.

The old way to do this mixing was to guess. The modern way is to call to the aid of the foundry foreman science and the skill of the practical metallurgist. It is to this method that I desire to call your attention, from the standpoint of the foundry foreman. Now, some foundrymen use the physical appearance alone to keep them out of trouble, without the aid of the chemical laboratory. To these I would like to submit what follows, and ask if this method is reliable under all circumstances.

We are buying our iron from several good and responsible furnaces, upon specification of the analysis for each grade wanted. In one of these which called for not less than 2.50 silicon, we got 1.82. On another calling for 2.00 to 2.50 silicon, we received one car with 1.37, another 2.90 and other elements varying just as badly. Had the mixture been made up by the physical appearance alone, there would have been many castings ruined.

Chemical analysis, used in conjunction with physical tests of bars cast from each heat, is a sure method of keeping your castings uniform. Physical tests are reliable only in detecting trouble, but are unable to remedy it without the aid of the laboratory. Both are important, and should, in my judgment, form a part of the practice in every high grade, progressive, and well regulated foundry.

The coke used has a direct influence on the quality of the castings produced. With this running high in sulphur, it is impossible to make a good quality of light castings which can be machined readily. Here is a case in point:

Our old coke contained 0.80 sulphur, and a new car ran up to 1.58. First day, old coke, witn 100 lb. high silicon iron in mixture, shrinkage was .158 lb.; second day, new coke, with 100 lb. high silicon iron in mixture, shrinkage was .171 lb.; third day, new coke, with 150 lb. high silicon iron in mixture, shrinkage was .168 lb.; fourth day, old coke, witn 90 lb. high silicon iron in mixture, shrinkage was .157 lb.

These conditions were experienced before we employed a chemist reguarly. Now we analyze the coke as well as the iron before using it.

HARD IRON.

BY H. E. DILLER, CHICAGO, ILL.

One hears a great deal of hard iron, and I used to wonder why foundries had so much trouble with it. As I had no trouble if I kept my silicon over 2 percent and the sulphur below 0.1 percent, it bothered me little what the foreman did with the metal, the castings never coming back, as but little machining was done on them.

Now, however, this state of serenity has been banished with the air filled with the differential system, the bonus system, automatic feed presses, making the rate, and what not, from the machine shop.

While the silicon and sulphur contents will take care of the ordinary run of castings with good sections, when it comes to much machining, especially on light castings, every point must be watched in order to get them as soft as possible, and here every separate element in the iron counts.

Phosphorus hardens iron to a slight degree. Silicon, by its direct effect, tends to increase the hardness, as does also sulphur. Where there is an excess of the latter hard spots are to be found throughout the metal. While they are not of adamantine hardness, yet the structure is such that the action of the drill forms a smooth surface, which wears the drill. A center punch can easily mark this skin.

A casting which it was impossible to plane was sent up to the laboratory from test. Several tools had been tried on it, and all that was accomplished at the hard spot was to take off a little of the skin and leave a bright steel colored surface. This could not be drilled, but by drilling from the other side the drill went right through this polished surface without the least difficulty. The analysis of the iron at the hard spot showed a little over 0.20 sulphur, and the combined carbon was below 0.50 per cent.

However, it seems hardly proper to call these spots hard, as the skin is only impervious to the drill or planer tool but can be dented with the chisel or center punch.

Graphitic carbon increases the softness of iron by breaking the continuity and forming planes of cleavage. It also acts as a lubricant when the iron is drilled. But more important than the direct effect of these different elements on the iron, is their tendency to increase or

decrease the percentage of combined carbon formed. Except when the total carbon is abnormally low, or the sulphur abnormally high, more can be told of the hardness of iron by the combined carbon present, than from any other indication.

Acting on this supposition when mixing iron for radiators, I had a sample of the previous day's heat sent to the laboratory each morning to be tested for combined carbon. This sample was made up from drillings taken from four different links at the place where they were to be machined. It was found necessary to keep the combined carbon between 0.4 and 0.6, and the total carbon below 3.50 percent. Combined carbon below 0.4 percent or the total carbon above 3.50 was almost certain to mean that the links would fail on the hydraulic test. When the combined carbon would get above 0.60 there was usually a complaint of hard iron, and when as high as 0.70 this was certain.

In a series of such everyday working tests it was found that putting high phosphorus irons in the mixture made it necessary to raise the silicon about 0.20 percent in order to get the same percentage of combined carbon in the castings. With high phosphorus irons, all other things being equal, a complaint of hard iron seemed to come quicker. Hence the advantages of the fluidity due to these classes of irons were deliberately sacrificed, and lower phosphorus irons used. Strange to say, that although radiator links are very partial to extremely fluid irons, there was no noticeable difference in this respect whether the irons ran 0.4 or 0.8 in phosphorus.

For foundries making a variety of small castings requiring extreme softness a good test is to make a small flat casting, of about the thickness of the smallest work, and regulate the mixture each day according to the amount of combined carbon found in these test pieces. In making such tests a curious circumstance was noticed. Two pieces 4 inches square, one ⅛ inch and the other ¼ inch thick, were cast. Invariably the lighter piece had the lower combined carbon, the average combined carbon of 60 samples being 0.14 in the ⅛-inch piece, and 0.20 in the ¼-inch sample.

The plan of judging the work to a large extent by the combined carbon in it can be used to great advantage in heavier castings. As one instance of this, let me cite a case of locomotive cylinders. The important part in them is the surface, which has to withstand the constant friction of the piston. This surface should be hard and close grained, and the test for this, it would appear to me, for shop purposes, should be the amount of combined carbon in a sample taken from the bore of the cylinder. The sulphur and the manangese should be watched also, but with the required amount of combined carbon secured, there seems to be no necessity for putting a low or high limit to the silicon.

If we knew the amount of each element in the iron, and its exact effect on combined carbon, as well as the way the iron had to be treated on its way from the cupola to the cold casting, there would be little use for determining the combined carbon. But under usual conditions it seems a good way of summing up the effect of a great many variables.

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AMERICAN FOUNDRYMEN'S ASSOCIATI[ON]

Papers for the Convention at Indianapolis, June, 19[04].

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Patternmaking in Its Relation to Foundry Costs.

BY W. H. PARRY, BROOKLYN, N. Y.

That diverse opinions on the art of molding are sometimes held by patternmakers and molders cannot be denied, and, if by the reading of papers and discussions on subjects of interests to these brother craftsmen, a better understanding will be brought about as to the needs of the foundryman in his endeavor to produce castings at the least possible cost, an immense amount of good will have been achieved at the very outset.

When we consider that a molder is compelled to make castings with practically no means to a successful end than a box or two plus a pile of sand, it is wonderful indeed in these days of keen competition that castings can be made commercially profitable.

In addition to being handicapped by the appliances at hand, the molder has very often to contend with patterns most fearfully and wonderfully constructed in that they cannot be molded in a practicable manner, and, on the other hand, patterns also, most beautifully made but "unmoldable" just the same.

The all too common practice of sending an order for hundreds of castings from one small pattern to be delivered in a day or two, is still with us, and nothing increases foundry costs more than this, except perhaps the good Samaritan who sends to the jobbing foundry a dozen or so metal patterns—minus a match board—so gated that all the dirty metal will enter the mold, thus assuring a high percentage of lost castings.

The loam molder who is fortunate enough to be provided with all the loose pieces necessary to complete his mold, is in luck, and how often does it occur that when the loose pieces are furnished, they do not come within a reasonable distance from his sweeps, or project inward or outward enough to necessitate amputation.

Another fruitful method of increasing foundry costs in connection with loam work is the growing disinclination to make the necessary core boxes, so shaped as to perfectly match the main loam core. The excuse is advanced that there are chippers employed in the foundry for this work. This procedure is the rankest kind of heresy and not fair to the foundryman or the molder who is making his best efforts to cheapen the cost of castings.

The making of patterns without fillets and marking the corners with dotted lines so that the molder is compelled to cut them, cannot be excused upon the ground that there is but one casting wanted, as wood or leather fillets can be bought and applied cheaper than the cost of the molder's time in slicking the round corner.

Unvarnished patterns with glue joints improperly made, or with daubs and beads of glue sticking out, especially in corners where the lift is greatest, does not aid the molder at all. It is moreover worthy of any pattern shop foreman's attention to see that patterns do not reach the foundry in this condition.

The use of cheap varnish is to be deprecated for all patterns, the more so on the larger ones that are apt to be left in the sand over night. It entails extra work on the molder in mending the mold, due to the glue oozing through the fresh varnish. In fact, it is not at all uncommon for the pattern to shed a fair proportion of its varnish coat in the mold itself, when exposed to the "touching" effects of moistened sand at night. Hence it would appear to be true economy to use none but the best varnish on wood patterns of all kinds.

The making large patterns in sections so that each part can be drawn from the sand independent of its neighbor, is very often a great help to the sand artist, and if it is possible to do away with deep cope lifts through the medium of suspended cores in the cope, so much the better for the foundry and pattern shop, in many instances.

Again, large or small patterns that are slapped together any old way by men who know better than to expect a pattern to be drawn from the sand without any draft, is very bad practice. It has been my "privilege" many a time to have witnessed good molders at-

tempting to make presentable castings from such patterns, only to have them returned as not being "true to pattern." One case in particular may be mentioned. A cement mill hopper frame some thirteen feet in length, by a width and depth of some six feet or so, was constructed with so little regard to the molder's feelings, that casting after casting was lost, until through the insistent demand of the foundry boss, a few inexpensive core boxes were made, which allowed the piece to be cast successfully and with less trouble and expense.

The placing of fillets on core-prints, where they join the pattern, to avoid a "crush" is good practice, and should be universally adopted, at least where cores of great bulk rest thereon. While it increases the chipper's work it decreases the chance for lost castings.

On complicated core work time and castings can be saved by having the set of cores made strongly wired without any attention being paid to venting them, and sent to the pattern shop, or any other suitable place, to be assembled on core jigs of wood. Any error can thus be detected and core boxes or core prints corrected while the concrete evidence of errors is present. When the object of these trial sets is explained to the foundryman, he will always be willing to provide them, as it lets him out of a lot of trouble.

To the list of shortcomings incident to the making of patterns could be added many more. The object sought in pointing out these little sins of omission and commission is, that while we have been guilty of these things in the past, there is no reason why they should be continued in the future, if the rising generation of patternmakers is to be taught that cheap work in the pattern shop does not necessarily produce castings as cheaply as they ought to be made in the foundry.

FOUNDRY ACCOUNTING.

BY KENNETH FALCONER, MONTREAL, P. Q.

That cost accounting presents in the foundry, problems not met in the machine shop, and difficulties not found in relation to other branches of manufacture is undeniable; possibly in no other industry does accurate "cost finding" imply so much attention to details, or necessitate such minute analysis of expenditures incurred. Like many apparent evils, however, this carries its own compensation. The end of cost accounting is cost reduction, and in any line of manufacture the possibilities of "cost reduction" are in direct proportion to the detailed knowledge available, and to the minute analysis made of the various elements which go to make up the cost of product. In other words, the special difficulties of finding the cost of the output of the foundry, give the results obtained special value as a means of lessening the cost.

The relative importance of the principles underlying "cost accounting" will depend very largely upon which word the emphasis is placed —upon whether the subject be regarded from the view point of the manager or the accountant. Too often the value of the results obtained is lessened by failure to realize that the question involved does not alone concern the matter of costs but that the best results can only be obtained when it is regarded as the science of accounts applied to the manager's problem of costs. In cost as in any other field of accounting, it must be remembered that for every charge made there must be a corresponding credit; that each account must stand for something, not only definite, but also definable; that the balance of any account whether debit or credit must represent an asset or a loss, a liability or a profit. If these be borne in mind the efficiency of the "cost system" and the value of the accounting results will both be increased.

In the business of making castings as in any other productive industry, the cost of each individual article produced is composed of three elements—material, direct labor and a proportion of each manufacturing expense incurred on account of or resulting from its manufacture.

It is only in exceptional cases that the conditions prevailing in the industry represented at this convention will permit of making each article the subject of individual record as regards any one or all of these elements. Leaving these cases aside, the alternative is to divide the output along what may appear the best lines into classes, and as far as possible make each class the subject of individual record as regards not only each element of cost, but each item forming each element. To do this all the elements of cost for a given period, say one month, must be divided by the gross weight of those classes of product on account of the manufacture of which each has been incurred, thus giving a factor of cost per 100 pounds applicable to a certain part of the product. For instance, if we assume that the weight of casting produced during a month, be divided into three "main classes" each of which is further divided when received from the foundry, into three sub-divi-

sions, it is clear that we have nine distinct lines of product amongst which to distribute the material consumed, the wages paid and the shop expenses incurred; this quite irrespective of whether the lines of division are based on the weight of the individual castings in each class, or the quality of the metal forming them, on the proportion of molder's wages paid for their making, or partially upon each.

If the three elements of cost be divided to as great detail as practicable, if each kind of material, each class of labor, and each item of shop expense for a month be recorded separately, each can be distributed on the cost of that part of the output which should rightly bear it without affecting the cost of other lines to which it bears no relation whatever.

The foundry "cost system" here described represents part of a complete system of "shop accounting" designed on these lines for a large brass works. "Anything in Brass" is the claim of the proprietors when asked the nature of their output, and it will readily be seen that the resulting conditions as they affect the foundry make a correct system of cost finding particularly difficult of application and also very essential to success.

It was found absolutely impossible to secure foundry costs by the plan of making each casting a subject of individual record in the foundry, and equally impossible to issue individual orders for the production of each lot of similar articles, and charge to such orders the labor and material directly expended on their manufacture. The fact that on a certain date there were over 1,000 unfilled orders on the foundry order book, and that of these considerably over 700 had been put in hand, and some part of the goods called for delivered to the shops or stores, will show that the keeping track of each day's expenditure of time and material on each individual order was out of the question.

The output is divided into classes designated by the letters A, B, C, D, etc., the class to which any casting belongs being determined solely by the metal of which it is composed.

Form 1 is a weekly time report and represents the time of all upon the foundry pay roll.

Form 2 is known as the foundry metal report, and must account for all metal melted each day. (Other supplies used each day in the manufacture of castings, and also the general supplies used in the foundry and given out from time to time are reported on similar forms.)

By a system of shop orders the fixed charges and the cost of maintenance for each month are accurately kept track of. These expenses, and also those represented by the consumption of general supplies are incorporated in the cost of the castings on the basis of a charge per hundred pounds. The amount so charged may not agree each month with the actual expenditures of this nature, but spread over a number of months have been found to very closely balance them. The aggregate of this charge against the cost of output is credited to an account known as "cost advance" to which the expenditures mentioned are charged out each month, and the rate adopted has been so closely figured that during a period of several years it has only been necessary to change it four times, and, *this is the important point,* in each case the reduction in the rate used has borne a direct relation to and resulted from the normal increase of the output from the foundry.

Form 3 is a card which accompanies any output of either good castings, gates or bad castings. As they reach the office these cards do not represent a full day's transactions, but, on the contrary, are merely reports of each lot or box of the good castings sent to the storeroom, or the bad castings and gates returned

Distribution of

Foundry Pay Roll __________ *Week Ending* __________

NAME	No.	Molding				Furnace Men	Pattern Stores	Fettling	Floor Labor	Metal Room	Core Room			
		A	B	C	D									
Total Hours						Form 1								

The Foundry

to the metal room. (It might be here noted that bad castings are credited to manufacturing account at the value of good castings, even though the defect be noticed before they leave the floor of the casting room. They are then charged back from the stores at the same price to a record account known as "defective work"—afterwards being transferred from "defective work" to "metal stores" or "scrap." "Defective work" account thus represents, on the debit side, the actual cost of the defective castings; on the credit side their value as scrap —the balance of course being the loss caused by defective workmanship.)

The double ruling on Form 3 for current and preceding month is to provide for accurate records of each month as distinct from those preceding or following. The entire quantity of castings molded in January may not be through the fettling room and reach the stores, in the case of good, or the metal-room, in the case of bad castings or gates until some part of February has elapsed, and the supplying on these forms of parallel columns to indicate whether the weights refer to the current or to the preceding month was found to be more satisfactory than using different cards for each.

The final record of the cost of output is made after the values and amounts represented on the other forms have been grouped together and tabulated by the cost department, and in view of the relation of each class to each expenditure of material, wages, as expense. It will be noted that the gates and bad castings are kept record of according to the class of the output of which they form a part. Their value is deducted from the charge for material against each class of castings at the average value per pound, as represented by the different metals composing the various classes. There is not so much clerical work and weighing necessitated by this system as would at first sight appear. The metal as issued from the metal room is placed in a set of shelves and bins lettered A, B, C or D, according to the class of castings in the manufacture of which it is to be used. At the close of the day, the amount left over in each bin is weighed and entered in the column marked "over" the amount supplied during the day being entered in the column headed "weighed in"—any metal left over in the crucibles is run into ingots and placed in the bins. The weight is marked in the column for "overs" and the value at which the cost department figures it is based upon the average cost of the metal of which it is formed. On the following day the foundry department makes no record on Form 2, of the amount left over in the bins from the preceding day's work, but simply enters the amount supplied and the "overs" for that day.

Metal Report *Date*__________

		BIN A		BIN B		BIN C		BIN D			
		WEIGHED IN	OVER	WEIGHED IN	OVER	WEIGHED IN	OVER	WEIGHED IN	OVER	WEIGHED IN	OVER
Copper	G.O. Ingot										
	XX "										
	Hvy. Scrap										
	Scrap										
	Light Scrap										
Brass Scrap	Red Hvy.										
	Red										
	Light										

Form 2 *The Foundry*

Output from Foundry
*Date*______ *To*______

		MONTH	
		Preceding	Current
Castings	A		
	B		
	C		
	D		
Gates	A		
	B		
	C		
	D		
Bad Castings	A		
	B		
	C		
	D		
	Form 3		

The Foundry

The cost department, in making up their figures add what is over the preceding day to the amount supplied on a given date, and deduct what is over at the close of the day, thus getting their net charge for the metal used each day for each class of product.

This cost system has been found of very practical value, but it is not as complete as the management hope to make it. The ultimate intention is to further subdivide the output, distinguishing between machine made and hand made castings, between cored and solid castings, and between castings made from the firm's own, or the customer's patterns, each of these subdivided into the qualities represented by A, B, C, D, etc.

SOME EXAMPLES OF IRREGULAR DISTRIBUTION OF SULPHUR IN PIG IRON.

BY JOHN J. PORTER, DUBOIS, PA.

The writer recently carried on a series of experiments involving the analyzing for sulphur of a large number of pigs of iron. While the original object of the experiments was not obtained, some rather remarkable cases of segregation of sulphur in the pigs were encountered, and these it is thought will interest the foundry metallurgist and others having to sample pig iron.

The fact that sulphur will seldom be uniform throughout the cross-section of a pig, has long been known. Mr. West, in his book on the Metallurgy of Cast Iron gives a number of instances showing sulphur to be highest in the top of the pig, and also states the reason for this phenomenon: namely, that sulphur (or sulphide of iron) being lighter than the iron itself, tends to rise through the molten metal and evaporate from its surface. The formation of a solid crust, however, prevents this escape, and causes the accumulation of sulphur near the top of the pig.

An illustration of this loss of sulphur from the molten iron occurs in the fact quite generally recognized among furnacemen, that the sulphur is, as a rule, slightly lower in the pigs than in the laboratory samples, which are dipped from the iron as it leaves the furnace and cast into chill molds to quickly solidify them. The segregation of sulphur is also well known among the furnace fraternity, and in consequence many of our chemists make a practice of drilling in or near the bottom of the pig when getting samples.

It is, however, the belief of the writer that it is not generally recognized how great the variation in sulphur may be in a single pig, and for this reason the accompanying diagrams are offered.

This table shows the variations in sulphur in cross section of pigs, the numbers of holes refer to accompanying diagram. These pigs were each from a different cast of foundry iron, the silicons ranging from 1.50 to 4.00, the manganese about 1.50, phosphorus .40, and total carbon around 4.00. All the sulphur determinations were made in duplicate, by the evolution method, without previous annealing of the drillings, and in several cases were checked with gravimetric determinations.

PERCENTAGE OF SULPHUR.

	Pig A.	Pig B.	Pig. C.	Pig D.	Pig E.
Hole No. 1—Top.	0.115	0.058	0.066	0.165	0.116
" " 2—	0.125	0.058	0.061	....	....
" " 3—	....	0.052	0.061	....	....
" " 4—	....	....	0.084	....	....
" " 5—	....	....	0.059	....	....
" " 6—Bottom.	0.040	0.030	0.029	0.175	0.103

It may be of interest, in passing, that the iron from this Virginia furnace running on native ores, invariably evolved *all* its sulphur as hydrogen sulphide without previous annealing, as shown by the close agreement with the gravimetric check analyses which were frequently made.

The analyses show plainly the great importance of the method of drilling in taking commercial samples. Pig A, for instance, showing three times as much sulphur in the top as in the bottom, while Pig C might be given any grade from grav forge to No. 1, according to where it was drilled. In this connection a standard method for sampling becomes quite apparent. It will be noticed that no invariably correct rule can be given as to the point of highest sulphur in the pig, for while it is usually found in the top, in No. D the reverse is the case, and in pigs A and C it occurs near the center.

The writer has also noticed an apparent va-

riation in the sulphur lengthwise of the pigs, as well as in the cross section. Having obtained drillings from the same hole in the same pig upon several different days, and finding that these drillings, when analyzed separately, would not check in their sulphur, a few experiments were made along this line, with the following results:

HOLE A. TOTAL DEPTH 2 INCHES. PERCENTAGES OF SULPHUR.

Sample Number.	Evolution Method.		Gravimetric Method.		Average.
1, First ½ in.	0.121	0.117	0.119	... ...	0.119
2, Second ½ in.	0.111	0.110	0.115	....	0.112
3, Third ½ in.	0.103	0.106	0.108	0.102	0.105
4, Fourth ½ in.	0.103	0.100	0.099	0.101	0.101

HOLE B. TOTAL DEPTH 1½ INCHES.

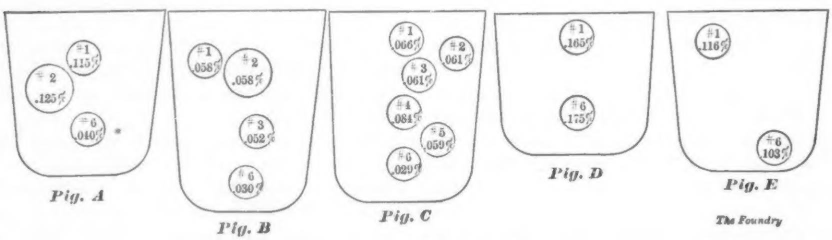
1, First ½ in.	0.048	0.048	0.050	....	0.049
2, Second ½ in.	0.047	....	0.045	....	0.046
3, Third ½ in.	0.043	....	0.040	0.045	0.043

HOLE C. TOTAL DEPTH 1⅛ INCHES.

1, First ⅜ in.	0.117	....	0.118	....	0.118
2, Second ⅜ in.	0.132	....	0.126	....	0.129
3, Third ⅜ in.	0.131	0.133	0.131	0.134	0.132

These holes were all drilled parallel to the longitudinal axis of the pig, and the results are given in detail so that some idea of the probable error of the analyses may be obtained.

Considering the fairly close agreement of the duplicate analyses by different methods, it would seem as if the variation in the percent of sulphur, shown by the different samples from the same holes, could only be due to longitudinal segregation. This variation, however, at least in the cases here noted, is not sufficient to be of great commercial importance, but, nevertheless, of scientific interest.



DISTRIBUTION OF SULPHUR IN PIG IRON.

CARBON.

BY F. C. EVERITT, NEW YORK CITY.

From the standpoint of the foundryman carbon is interesting only as he finds it in his iron and the fuel. In coke or anthracite, it is present as the so-called fixed carbon, or in a form easily burned and giving off heat for melting purposes, as well as uniting chemically with the iron it is in contact with.

In our irons we find it as free carbon, or graphite, and combined carbon, or a chemical compound of iron and carbon. In pig iron it as a rule seldom exceeds 4.25 percent, its solubility being greatly influenced by the presence of associated elements. In chrome iron a maximum of 12 percent carbon is recorded, while manganese iron may take up 7 percent. When the silicon present is 20 percent, the minimum solubility of carbon is obtained, or less than 1 percent.

Carbon is a most active element in cast iron. It determines the melting point, hardness, and strength needed for the various classes of work. When iron is molten, the carbon is in solution, and it is through the influence of the other elements that we get a precipitation of the graphite. The condition which the carbon assumes on solidification of the cast iron is dependent partly upon the rate of cooling, and still more upon the nature and quantity of the associated elements. Slow cooling assists in the production of crystals of larger size than would be the case where the cooling is more rapid. Some grades of iron, otherwise white, may thus be rendered gray, by slow cooling, while other gray iron can be made white by rapid cooling or chilling. The latter is seen in the making of machine cast pig iron where the furnace iron is cast into molds and these pass through water and chill very quickly. The effect is, however, only a change of what otherwise would have been graphite to combined carbon, for when this iron is remelted and cast under normal conditions, it comes out gray again.

Carbon affects the strength of iron more than any other element, in its appearance in the combined or graphitic states. If the latter the iron is bound to be softer, weaker, though tougher than if the carbon is combined, when the castings are harder, more brittle, but stronger. As between the white and the dead gray irons the strength will be a series of variations from one set of characteristics to the other, all the other elements remaining the same.

As the combined carbon is the important thing to watch for the machine shop it will be interesting to note the percentages required for given conditions. Here they are:

For extra soft gray iron, combined carbon should not be over........	0.08 %
For ordinary soft gray iron, combined carbon should not be over......	0.15
For iron of maximum tensile strength, combined carbon should be........	0.50
For iron of maximum transverse strength, combined carbon should be	0.70
For iron of maximum crushing strength, combined carbon should be	1.00

These figures are subject to variation according to the size of the castings, and the percentage of the other elements present. The influence of these elements on carbon is of great importance. Manganese and chromium increase the solubility of carbon in iron, and hence more is found in irons high in these elements. Moreover, holding the carbon in solution causes these irons to run toward whiteness.

Silicon diminishes the holding power of iron in regard to the carbon, hence the precipitation of graphite when silicon is present in quantity. As silicon is so very influential in this respect it is practically the basis of all our foundry metal mixing.

Sulphur acts very powerfully to combine the carbon, but as this must be kept down in the mixture for other reasons, it should not be allowed to become important enough to interfere with the mixing programme. Phosphorus also increases combined carbon, but not sufficiently to interfere much.

In conclusion, while silicon is the basis of our mixing, the carbon question should not be forgotten, as when the amount of this is not normal, even silicon will not act as we have reason to suppose it should.

PIG IRON AND ITS CONSTITUENT ELEMENTS.

BY H. L. WILLIAMS, CHICAGO, ILL.

We find pig iron and castings made up in the main of metallic iron, carbon silicon, sulphur, phosphorus and manganese. The other elements, such as titanium, copper, arsenic, etc., seldom being important enough to cause trouble.

Metallic iron runs 92 to 94 percent in our foundry and mill irons. It is the same whether in pig iron, steel, wrought iron, castings, etc. Were it alone to be considered we need not worry about grading by fracture or analysis. We must look for the differences that occur in the various classes of irons, in the additional elements present. To control these foreign elements is the task of the founder.

Carbon is most important in cast iron. Its effect on iron is positive and varied. Free carbon, or graphite may be either in the pig iron between the crystals, or if in considerable excess, leave the iron at the moment of set, and fly off as "kish." Combined carbon, or the carbon which remains in combination with the iron is the hardening substance in iron, and when all the carbon is present in that state, leaves it perfectly white. This is turned to practical account in making chilled castings, the effect of a sudden cooling of iron by throwing into water, or casting against a heavy body of cold iron promoting the retention of the carbon in the combined state. In this way car wheels, crusher work, rolls, and the like are made, with iron otherwise gray if left to

cool slowly. If a casting is too hard a correction must be sought in freeing more of the carbon and getting it into the graphitic state in subsequent castings. Hence softness and hardness of iron in foundry work is chiefly controlled by carbon.

Silicon in iron frees the carbon, depending upon the amount present, the shape and weight of the casting, and the pouring temperature. In other words the rate of cooling. If the iron is high in combined carbon and hard, add silicon to soften it. It will do this unless prevented by too much sulphur phosphorus, or manganese. If the iron is too soft, reduce the silicon. If the iron is too hard, and low in total carbon, too much silicon is not good, as it is only effective through its action on carbon.

More silicon is required in thin castings than in heavy ones, as the latter cool slower, and give the carbon time to separate out, while the former cooling quickly chill more, and keep the carbon in combination.

Manganese increases the affinity of iron for carbon. In heavy castings it is well to have 0.80 percent, and in light work only 0.50. With these proportions the metal will be clean and strong. Below 0.50 the metal is inclined to sponginess, and above 0.80 there is a chance for hard iron. Manganese also reduces the sulphur present. In chilling work, high manganese gives a strong, hard, sharp chill. It can be used up to 3 percent in such mixtures.

Phosphorus increases fluidity, corrects shrinkage, and is desirable in the foundry up to 0.50 for ordinary foundry castings, and up to 1.25 for ornamental products. Phosphorus hardens iron, and very much of it requires plenty of silicon, to neutralize the effect. Excessive phosphorus with low silicon makes bad foundry work.

Sulphur combines carbon, erratically causing hardness, closing the grain, and weakening the castings. In ordinary castings it should not exceed 0.09, but may go above this in common work requiring no machining. It is the great enemy of iron and should be kept out as much as possible. The fuel is a fruitful source of sulphur, hence this should be watched.

It will be noticed that silicon opens the grain of iron by freeing the carbon, while all the other elements close it by retaining the carbon in combination. In these effects we find the relation of grading by fracture and chemical analysis.

Papers for the Convention at Indianapolis, June, 1904.

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The Need of Modern Foundries 8

Payment of Labor.

BY JOHN MAGEE, CHELSEA, MASS.

Probably there has never been a time in the history of manufacturing business when we have heard so much regarding payment of labor, as at present, and that many have heard more than they wish is evidenced by the growth of defense associations all over the country. In their side of the question, we as an association have no interest, but in the causes that lie back of all this unrest, and in the changes that will be brought about by it in factory methods, we have a fruitful field for study and investigation.

Of course the greatest problem is the wage question, and when we look back and see the arbitrary powers that have been vested in the employers during past years, we wonder how the old way was allowed to remain living as long as it did, by the employes. It is not at all surprising that there has come a change somewhere.

There is at present a great movement in the business world due to the overturn and to the fact that there is as yet no universally successful method of meeting the situation in which the workman, or his representative, takes part in fixing his pay.

Searching the primary reason for the change, we easily find it in the education of the American workman, and to that we can trace the upheaval of modern labor and the uneasy times we are passing through. It all indicates dissatisfaction with the present wage system, and no man ever accomplished much in the world without a certain kind of dissatisfaction properly expressed; improper expression of it, in his particular case, and the extreme position ken by some of the unions being the weak ints.

At first came demands for horizontal in- ases for all the workers, regardless of their ty or the capability of the trade in question to comply, and much was heard of the minimum wage and limitation of output. These principles were ideal from the standpoint of the poorer worker and were immensely popular in the early days of unionism in America, but are becoming of less and less importance; largely due to their great unpopularity with manufacturerers, and although the old principles are still stolidly affirmed, they are not of the practical value today that they once were, and their individual application is entirely a dead issue in some shops, where the newer intelligent unionism is furthest developed. In the past, most unions have shown a violent opposition to graduated payment for labor; and we find a great reason for this dislike in the fact that with a piece work system it is difficult to establish a minimum wage and limitation of output; but in spite of these objections, the opposition is not so violent today as it has been, and although still outwardly opposed, various systems of this kind are largely used by the industries best suited to them, and in many shops have the tacit approval of the unions. One point which many men seem to overlook is the fact that, while in good times an employer sometimes gets an exorbitant profit, on the other hand he sometimes fails to make any thing in dull times, while wages change only slightly.

The worker, if he demands his just share of prosperity, must also take his share of the lean years, and in so doing, there has arisen a need of a flexible scale that can be better adapted to varying conditions than day work can ever be.

That we are fast approaching a complete system of pay graduated to the ability of the individual, conditions of trade, and price of commodities, seem clear; and on the eve of this industrial change it may be of interest to glance at some of the plans that have been proposed and used at various times, and with varying successes, to leave the earning power of the workman in his own hands and give a larger reward to the individual who accomplishes more or better work than does his neighbor.

We are all aware of many methods in dif-

ferent industries and under different conditions, but few who have not looked into the matter a little, realize what a large variety there is, and how varied their points of view. They may be broadly classified into nine groups, which we will designate as Day Labor, Piece Work, Premium Plan, Differential Rate System, Profit Sharing, Gain Sharing, Contracting, Cooperative Piece Work and Participation.

In favor of day work, we have the extreme simplicity and low cost of the office accounting, the fact that the method is well understood by the workman, and a belief in the mind of many that the work produced is of higher quality than with other methods which are commonly supposed to rush a man too rapidly and make him careless. All these are strong points in its favor, but more than offset by the advantages gained with a properly planned piece price system. From the manufacturer's point of view, a large argument in favor of piece work is that every man has every incentive to produce a maximum of work in a minimum of time provided he wishes to do so, and that an efficient remedy for any drop in the quality is found in proper inspection of the work produced—which should exist under any system, but is one of the points where a false economy is often practiced.

The importance of this proper inspection cannot be over-rated, and when its value is realized, the quality of work produced is actually of higher grade than is similar work produced by the day, as may be readily understood when one considers the fact that the workman makes up for all defective work out of his own time.

With day work there is certainly little tendency for a man to slight his work, but, on the other hand, there is no pressure to make him improve, except pride in what he produces—often a pull in the right direction, but not such a hold as is the question of dollars and cents that arises when he is called upon to make up defective work out of his own time, as must be done if he is under the piece work system.

It does not seem probable that one who has given the matter thought, can fail to see the great advantages offered, although there are of course many places where day-work is the only possible solution of the problem, due to local conditions, such as union opposition, prejudices, or suspicions of the workmen, that have arisen, generally, from unfair treatment.

In straight piece work, we find that a man receives a certain sum for doing certain operations, payment being only made when the quality of the work is acceptable. Prices under this method may be established in either of two ways: By giving the job to a good man and after finding his time on it, making the price so that he will be able to earn a fair day's wages—due allowance being made for the fact that more often the work is done quicker it may be done—or by pricing from a similar piece that has been well and satisfactorily established.

Prices must be made with great care and must be satisfactory to both employer and employee, and after having once been established must never be changed except for a general advance or decline in wages, change in appliances for doing the work, or similar reasons. They should be so set that the average man can make an average pay, and then if through unusual exertion, skill, or longer hours, some individual makes more than a usual day's pay the price should not be cut, as is often the case, nor should a poorer workman be forced to this exceptional output. Abuse of these last points has been responsible for nearly all the trouble that has arisen from piece work systems, and a proper realization of their value is essential.

It should also be remembered that the amount of superintendence required is greatly reduced, and it is quite common to find piece work departments running themselves without any foreman.

The premium plan is one of the most interesting ways of paying labor, and has many good points, were it not for the great distrust that labor seems to have for it, probably due to the fact that it is more complicated than some of the others and is not so readily understood. The man is paid a certain sum per hour, a time is set on every piece, and a premium is paid for every hour that is gained in doing the work under this time allowance, the premium always being less than the man's wages per hour. An example will illustrate:—Let us say that our man is getting thirty cents an hour, and is working on a piece for which the time allowed is ten hours. The premium in this case is twenty cents for e[illegible] hour saved. The piece then costs regu[illegible] ten hours labor at thirty cents per hour [illegible] total of three dollars. Now let us s[illegible] that one man through unusual exertion [illegible], or incentive offered by the prospect of higher pay, does this work in nine hours. It will then cost nine times the rate per hour of

thirty cents, or two dollars and seventy cents and as our man has saved one hour, he will also get the premium for one hour, which is twenty cents, and makes a total of two dollars and ninety cents. This is a saving of ten cents for the company and the man has earned two dollars and ninety cents in nine hours, or thirty-two and two-tenth cents per hour. He will earn three dollars and twenty cents instead of three dollars for his ten hours, provided he maintains the same rate of speed for the tenth hour that he has for his first nine. In other words, the faster the work is done, the greater the sum paid per hour. It seems hard for the workman to get a true appreciation of the many advantages really contained in this plan for both sides to the transaction, as has been shown by trouble in many places where it has been tried. (As in the foot-note attached*) The worker fails to appreciate that he loses nothing but always gets his two dollars and fifty cents or three dollars, or whatever the daily wage may be, and the premium is entirely additional.

The differential rate system consists in paying a higher price per piece if the work is done in the shortest possible time, and done without flaw. Suppose that ten pieces is the smallest day's work for which it is considered profitable to retain the workman, and the piece price has been set at fifteen cents per piece. Now if a workman does a day's work of only ten perfect pieces, he receives ten times fifteen cents, or one dollar and fifty cents. But suppose he turns out twenty pieces, then, instead of fifteen cents, he gets, let us say, eighteen cents per piece, and his day's work nets him three dollars and sixty cents. Should he finish twenty pieces, but have some defective ones, the price per piece would not be so high as when they were all good, and he might receive seventeen, sixteen, or even only fifteen cents, according to the proportion of defective ones. Of course, in addition to receiving a lower price, he would receive nothing for all the unsatisfactory ones. It will be noted that pay for the better workman increases rapidly above a certain point. The system is in use principally where the work is done with valuable machinery that must be worked to best capacity, and where it is economy to secure this result even at an increased cost per piece.

The piece work plan, premium plan, and differential rate system, are really all variations of the premium plan, for a few figures will convince that when the hourly premium is equal to the basic hourly pay, the system becomes regular piece work, and when it becomes greater we have a form of the differential rate system.

Profit sharing should also be considered. Here it makes little or no difference how the workman is paid as he always has his incentive to better work, and more of it, in the interest that he has in the profits of the business. These are usually determined twice a year, a certain part being set aside for the capital end of the business, and the rest divided among the employes (salaried men excepted, as a usual thing) in proportion to their wages since the last division. In some shops this is varied by not sharing profits with any man who has not been in the concern at least six months or such a time as shall be determined.

In other plants the men are made actual stockholders, by one means or other, the stock that is held by the employer being in the nature of preferred stock, while that held by the employee is sometimes tied up so that it is not owned outright, but given for use while in the employ of the company. The idea is not in general favor with the workmen, owing to the fact that a cash payment is often required on the stock, and that this is sometimes the drag to hold a man in place when he could better himself by a change. There are many variations of this idea, and the application depends entirely upon local conditions.

Gain sharing is where only the gain, say in cost per ton, is distributed. Here the saving in the cost of running the plant is carefully figured out and is divided, part being retained by the employer, and part divided among the workmen, in proportion to their wages.

Another system in common use is known as the contract system, where one man is selected, and a contract made with him, he hiring his men, and conducting his business as he sees fit, generally paying them by the piece. This is really a combination of day and piece work, and in the foundry, finds its chief application in the machine shop. It is not always satisfactory, and is open to the abuses of both the systems of which it is composed.

Looking over the co-operative plan, we find something a little different, the prices being estimated and established much as in any other system, but not used directly in paying the workman, who works by the day. From his wages and the number of pieces that he produces is calculated the actual cost of each piece. The difference between the estimated and the actual cost, or the gain, if any, is divided between the employer and employe in addition to his regular wages.

Participation divides the gain in the cost of manufacture among the foremen, generally in proportion to the pay-roll of each department. This is a modification of gain sharing, the chief advantage being that each foreman is left free to establish such systems of rewards as may seem best suited to his department.

In all of these systems, prices should be set so that the workman can earn a regular day's pay for an average day's exertion, the extra pay idea coming into play only for extraordinary exertion, or skill. Every plan that has been mentioned is in practical use, and there are places where each will be successful but nothing can be done with any of them, without cooperation, thorough *understanding by the workmen*, and fair treatment by the employer.

*Editorial from the Iron Molders Journal, April, 1904.

Against the Premium System. The city of Cleveland will again see what may develop into one of the most bitter strikes between our members and one of the largest corporations of the country, and No. 212 will again have to bear the brunt of the contest. In the early part of the year the Westinghouse Manufacturing Company closed their foundry, where some 140 molders and coremakers were employed, and at the time advised them that when the plant reopened they would expect their employees to abandon the day-work system that had formerly prevailed and adopt what they chose to term the premium plan.

Our members, being opposed to this system, as they believe it to be most injurious and unfair, submitted their grievance to the Executive Board while they were in session, and the Board, feeling that the firm was endeavoring to force a most obnoxious system upon our members, sanctioned the strike.

The premium system, as proposed by this firm, is one that takes from the molder one-half of what he earns and over and above what the firm chooses to call a day's work. The system in operation is a simple one, and can be readily understood. Each pattern is tagged, but instead of a piece price being given, so many hours are allowed for the job at so much per hour. For instance, a small bed plate is given a molder, for which he is allowed 15 hours, say at 30 cents an hour. Should he begin work on Monday morning, work 10 hours during the day and close his mold at noon on Tuesday, he would have $4.50 credited to him. If, instead of this, he exerted himself more than ordinary—and this is what the firm expects him to do—and managed to close the mold on Monday night, he would have to his credit $3.75, or 12½ hours' labor at 30 cents per hour, the firm taking for its share one half of the time the molder had been able to save over and above what they rated as ten hours' labor; or, in other words, the firm would deduct one half of all the molder was able to earn above what the firm termed a day's work—for every extra dollar the molder earned he would have to give one to the firm. It is difficult to understand how it is possible for a fair-minded employer to defend a system that penalizes a workman for exerting himself in his employer's behalf, and that says to him, you must give me one-half of the extra money that you have earned.

Methods such as the one just mentioned have no place in the twentieth century, and we expect that the Cleveland molders will be able to convince this firm that no man is willing to work for them under the conditions they impose.

THE ENGINEER IN THE FOUNDRY.

BY DR. R. MOLDENKE, WATCHUNG, N. J.

It is not so very long ago that when an engineer had to do some detailing in which cast iron was used, that he simply figured on a strength of ten thousand pounds per square inch, and let it go at that. Today more is required of a man up in his profession. Where the use of cast iron is advantageous, it makes quite a difference whether ordinary cupola metal is employed or the highest grade gun metal. In other words the engineer should know something of the several kinds of cast iron made, how they are made, and how used to the best advantage.

The best indication of this modern tendency is seen in the recent presentation of specifications for testing cast iron and finished castings. These arose from the demand of the buyer to know what he is paying for, and as a consequence he is learning to specify his wants more clearly. Then also there is the desire of the engineer to acquaint himself with a material he is called upon to inspect for the buyer, and pass upon as good for the purpose or not. Finally the foundryman himself, in his most broad-minded form, has always been desirous of giving the customer the best he can make, and indeed must do this or find his product replaced by the malleable or steel casting. All these tendencies have brought about a general getting together of those most interested, with the result that for the first time in the history of the iron industry has a com-

mon ground been found for working specifications governing the testing of cast iron and its products. We will therefore look into this subject more closely, and see how the engineer can utilize his knowledge of metallurgy in dealing with the foundry.

For the purpose of the engineer we can divide the general subject cast iron into the following heads: The metal without subsequent extended annealing, or all classes of cast iron proper; and with subsequent extended anneal, or malleable cast iron. I say extended anneal to distinguish the removal of the casting strains simply in any kind of casting by the application of moderate heat for a short time only, from the long annealing given a special class of white iron which is unfit for use in its condition as it leaves the molding floor, but becomes tough and malleable, as well as just short of steel in strength after the heat treatment has been applied.

Cast iron may be further divided into the gray varieties, and the chilling irons. The gray varieties may again for our purpose be divided into the ordinary jobbing castings, such as for buildings; the machinery irons, light, medium, and heavy; the special irons made in the furnace, which run up to 35,000 lbs. per square inch and over; and finally the softer irons, such as would find their best application in ornamental work. Stoves, art castings, novelty work, etc. would come in here. There are some sub-classes to be considered here, such as iron for pipe cylinders, refractory metals for grate bars, and the stuff only good for sash weights and floor plates.

In the chilling irons we find first the car wheel iron, which is both soft and hard, depending upon the mold it has been cast into; the roll irons; and special work such as for crusher jaws, grinding mills, and the wearing parts of machinery.

It will be easily seen how the civil engineer will be specially interested in cast iron going into railroad and bridge construction, whether for actual working parts, or merely the ornamental end. Similarly in the designs of buildings, whether terminals or sky scrapers. The mechanical engineer naturally has more to with cast iron and runs through the whole gamut in his daily practice. In the railroad service he deals with malleable as well as gray iron castings in his car construction. The locomotive adds some steel castings to these. Then the cast iron car wheel will give him enough to think of, as will be seen from the specifications alone. In the machine shop, rolling mill, and in the foundry itself, the mechanical engineer should be a master in adapting this metal, in its various forms, to the purpose in hand, and hence he cannot learn too much of the production of all classes of castings, gray, chilled, malleable and steel.

Finally the mining engineer, who has probably to suffer most from breakdowns with iron castings, as he is always isolated and must transport his repair parts great distances. He also should know something of foundry practice, as he could oftentimes help himself by "burning on" a broken piece, if he but know how to rig up a temporary cupola out of an old boiler shell, and drive compressed air into the charge.

Some distance across the border down in Mexico, I saw a foundry which made it a business to cast repair parts for the various mines tributary to the city wherein it is located. This foundry used but little pig iron and much scrap, the scrap being inferior, and the pig iron worse, the result is not to be wondered at, and hence it is the custom to send a duplicate order to the States for the same piece, which usually arrives just when the Mexican casting breaks. Had some of our young engineers in such regions knowledge of foundry metallurgy, they could take charge of the foundry for the time being and get creditable results, and the double expense and vexation would be avoided.

Taking up first the pig irons, in the light of the specifications governing their purchase. We note that the charcoal irons form a special class by themselves. The cold, or moderately warm blast used, together with the more perfect reduction of the ore, produces an extremly sound and strong metal which cannot be always duplicated in the hot blast coke process This iron, therefore goes into the highest grades of castings, and cannot well be covered by ordinary commercial specifications governing the great bulk of the pig iron made. Similarly the high silicon irons, and the ferro-silicons are a class by themselves. Being used only in very limited quantities, their impurities are not so important, so long as there is a great preponderance of silicon for mixing purposes.

Two cardinal requirements are laid down in specifying for pig irons. The content of silicon and of sulphur for the grade numbers known to commerce. These are as follows:

Grade.	Silicon.	Sulphur.
No. 1	2.75%	0.035%
No. 2	2.25%	0.045%
No. 3	1.75%	0.055%
No. 4	1.25%	0.065%

A clause is added to the specifications intended to take up the personal equation in sampling and in the analysis of the sample, a lee-way of 10% being allowed in the silicon, and 0.01 in the sulphur that may be above the table. This variation may be doubled before the iron can be rejected, but a penalty is provided, thus reducing the cost to the buyer. While this penalty is small, yet it is only fair to the furnace man who has so many kinds of iron to pile up and care for, while the foundryman can always help himself with the iron he receives by judicious mixing. The better posted the foundryman is, the more liberal he will be with his pig iron dealers. Personally, I have never rejected a car load of iron in my life of the several hundred thousand that have passed through my hands, but once in a while there have been heart to heart talks with the agents, resulting in concessions in price, and the iron was suitably mixed up and used. With these specifications and the assistance of a commercial laboratory, even the most back-number foundryman can get suitable iron for his castings, without relying upon the uncertain fracture appearance of a freshly broken pig, as he has done heretofore.

Perhaps the most important of the specifications from the standpoint of the engineer, is that for testing cast iron as a metal. This is the result of years of thought and experiment by engineers' and foundrymen's associations, as well as independent investigators, thoroughly digested by those who were most active in this work, and the result approved by a majority of the cast iron experts of the country. The following principles were recognized. In America we prefer to judge a casting which cannot be tested to destruction, by the quality of the iron entering into it. That is to say, by pouring the melted iron into test bars, under standard conditions, and then testing these bars to form conclusions therefrom. Next it is recognized that these bars should be made of as large a section as possible, consistent with a proper structure, or constitution of the iron, to avoid the artificial influences of damp molding sand, variations in pouring temperature, cooling strains, etc. Also to keep the tests within the limits of the ordinary testing machines found in our foundries.

Then comes the cross-section of the bars, the round form being better than the rectangular, as it avoids the artificial cooling at the corners. Next the manner of casting. Experience has shown that a bar cast flat, when tested in the position as cast gives different results from those obtained when the bar is reversed. Hence the importance of casting the bars vertical. The refinement of the bottom pour, though giving better results, is too cumbersome for commercial use. A suitable rotation in the casting of these bars is necessary, so that the results may be representative. The bars are not to be tumbled, as this would remove casting strains, and make the material artificially strong when compared with the castings themselves, which are not so treated. Finally comes the testing of the bars themselves, which experience has shown to be best accomplished by placing them upon supports 12 in. apart, and breaking by applying the load at the centre. The deflection is also noted.

The best way to test castings is to take say three out of a batch of 103, all being made from the same heat and under the same conditions, and actually breaking them under as nearly service conditions as may be. For instance, the car wheel is now so tested in practice, not only by using the drop weight on it until shattered, thus giving the extreme of the pounding it would get in service; but by pouring around the chilled rim, a stream of melted iron, and noting the effect. Here again the extreme effect of the brake is applied to the wheel. If the three wheels thus treated will come up to expectations, the other 100 are accepted. Thus it will be seen how careful material is looked over where life and property hang in the balance. In making boiler castings, everyone of them should be subjected to the hydraulic test, and put under pressures at least 2½ times as great as the one to be kept up in actual service. If on going over the castings carefully during the test, they stand up all right, they may be regarded as safe. Similarly a number of classes of other castings are tested under actual service conditions with very good results.

The great bulk of castings, however, do not lend themselves to such tests, and hence it is necessary to pour bars to judge the iron as poured. The art of the founder should then insure the quality of the castings made to be as nearly that of the test bars. This, of course, is not always the case, but the buyer soon learns where he can get the best work suited to his requirements, and hence the incentive on the part of the founder to do the best possible for him. With a good iron as shown by the test bar, it is possible to make bad castings, but with a bad iron as shown by the test bar, it is not possible to get good castings. Hence our American method of giv-

ing the test bar the best chance possible, in order that one gets a correct idea of the situation, and can size up the founder's ability to do good work, or his judgment in buying good or bad irons. There is nothing better than to have the foundry laboratory open to the free use of the inspector, so that he can see the shop tests before him all the time, whether for his work, or that of the general run. This creates confidence, and invites suggestions for betterment all around.

One of the things the engineer should know is when and where to use cast iron. I have always felt that this material has no business in structures where life may be endangered in case of accident, other than in the ornamental portions. The cast iron bridge member is now fortunately a relic of the olden times, and gradually cast iron has been replaced by steel where lightness and strength is an object. These tendencies can of course be carried too far, for there is no economy in using expensive steel construction in places where cast iron will do just as well. Wherever there is a quiescent load, which requires a material with high crushing strength to sustain it, there cast iron will be found most valuable. Wherever art work is to be added to the cold and bare constructions of the engineer, there cast iron is essential. The fact that last year some 3,600,000 tons of castings were made here shows what this industry means to our country.

I therefore commend the foundry to the engineer's most earnest attention, as he can hardly turn about in his professional work, without coming into contact with its products. With the excellent literature now available in this branch of the arts, with a progressive technical press, and the welcome he will get in visiting foundries, there is no reason why an engineer should not be well posted on cast iron and thus make experience serve him all the better in the daily problems of his profession.

MOISTURE IN MOLDING SAND.

BY W. S. MOREHOUSE, NEW YORK.

Early last March a quantity of molding sand was received at our foundry. It was a case of too much foundry work for the size of the sand storage bins and the stock had to be replenished regardless of weather conditions, consequently it came in wet. It looked as though it had come from a wet place, had been transported in wet weather, and in a leaky boat.

Several samples were tested, and all contained about 18 percent water. It seems too bad to have to pay for much water at sand prices, and I started on an investigation of the subject. The foundry literature on hand afforded no information. An appeal to Secretary Moldenke confirmed the impression that authors of foundry books had overlooked this matter, or considered it of too little importance for notice. Our secretary suggested that I investigate and prepare a brief paper on the subject that would lead to an intelligent discussion and the determination of a right and proper limit of moisture in molding sand when received from the sand man.

An informal little circular was prepared and sent to a few acquaintances and others interested and concerned in foundry matters, asking their experience and custom, and inviting their suggestions as to the moisture limit. There was a very kind and prompt response which developed the fact that no limit for moisture had been established by any of the people addressed, but the subject has had thoughtful attention.

A few quotations give the gist of the replies: "We buy in dry weather." "Our molding sand is purchased in July and August." "We have on one occasion refused an entire cargo owing to its being thoroughly saturated with salt water." We simply refuse to accept a boat load of sand that comes in an unusually wet condition. It is generally enough to make one such refusal." Another calls attention to the fact that molding and core sands are sold on close margins and that if one is compelled to get sand out of the favorable seasons, it is better to take what can be had, and not be too critical. The dealer is anxious to accommodate and hold his trade, and often undertakes to supply sand, when he knows that he will lose money on the deal.

The replies show that molding sand is generally purchased by the ton of 2,000 lbs., though occasionally the 2,240 lb. ton is used. Core sand is sometimes measured and 23 cu. ft. to one cu. yd. for a ton of 2,000 lbs. is used.

The inference from all this would seem to be at the present time: Get sand in the dryest weather possible, and get enough to last until the next dry season. If you get caught short, make the best possible bargain with your dealer, and do not be afraid to bear on, for he will meet you half way to hold your trade.

This is not satisfactory to the modern foundryman. In these days of progress it is far better to have definite standards to relieve the situation, than to browbeat the dealer, or take the chance of being imposed upon by careless handling. An excess of 10 to 15 percent of moisture in a cargo of molding or core sand

represents a sum that is big enough to be seen, and be an element in the cost accounts.

It is the object of this paper to draw out discussion and bring about a comparison of customs, experiences, and ideas. Still better if a committee were appointed to propose definite standards of moisture allowable in foundry sands, with appropriate commercial regulations, similar to those for the purchase of pig iron, now being introduced.

DISCUSSION ON COST KEEPING.

BY W. S. MOREHOUSE, NEW YORK.

I cannot quite resist the temptation to take this opportunity to say a word about the very important matter of cost keeping. Now, you who have noticed the somewhat fearfully and wonderfully wrought up systems of cost keeping that our enterprising trade journals have brought to light during the last two years, will be looking for the exits. Pause a moment, and realize that a successful foundry business that is satisfactory to owner and employes owes its success and prosperity in a great measure to the perfection of a lot of details, great and small, and there are a lot of details to help and hinder a foundry.

It pays handsomely to keep costs, to know what the molders and coremakers are doing, to know how much a new rig helps out on a day's work, to know whether that new core-compound substantiates the claims made for it. It benefits all concerned to know how to bid on jobbing work to make a fair profit, enabling you and your competitor to live and let live.

THE NEED OF MODERN FOUNDRIES.

BY DAVID SPENCE, CHICAGO, ILL.

One of the crying needs of the foundry industry today is up-to-date shops. Only with these can first class work be turned out most cheaply. In building a modern foundry, the wisest thing the owners can do is to get a first class foundry superintendent and have him assist in the drawing up of the plans. The buildings should be high enough to insure good ventilation, and give plenty of light. Good cranes should be provided, as well as core ovens, and a track running through the foundry, properly provided with turn-tables at each end and in front of the cupola. This track should extend out to the yard, so that large flasks can be loaded and run to their place with little help, instead of calling off all hands for the purpose, which may be seen in many places.

The shop should have a good cupola stage. I have seen otherwise well designed and built foundries spoiled in their cupola arrangement. A stage for the cupola should be large enough to hold three heats of fuel and iron. When I erected the stage for the first foundry of the B. F. Sturtevant Co., we could put a car of iron and a car of hard coal on it, and then have room for our scale and to work.

Another important point for the foundry is a good core-room, with plenty of space for the men, and shelf room for the stock cores. This room should be made as pleasant as possible. Here, as well as in the rest of the foundry, modern conveniences will add much to the comfort of the men, keep them contented, and enable them to produce more and better castings than are made in many of the make-shift shops in which it is hard to tell where a man can work.

We need up-to-date foundries as much as we need the best of sand, facings, and iron to produce the best results. The men, moreover, take more interest in their work. There has been a marked advance in the foundry industry within the last twenty years, and much of this may be traced to modernizing the shops.

AMERICAN FOUNDRYMEN'S ASSOCIATION.

Papers for the Convention at Indianapolis, June, 1904.

Notes on a Successful Piece Price System 1
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Notes on a Successful Piece Price System.

BY JOHN MAGEE, CHELSEA, MASS.

In these days of profuse trade literature we hear much concerning shop methods, accounting and kindred subjects, but somehow the foundry does not seem to get its share of the modern ideas that are coming into use, and particularly there seems to be little available information in regard to determining pay under the piece price system. It may therefore be of interest to set forth the outline of what has proved a successful way of handling the problem in a large specialty foundry.

As we all know, the detail of this class of work is very great, since it is not uncommon to find over five thousand patterns regularly used in a foundry of this kind, each of which must be priced every time it is made, which (together with the accounting for the defective work not paid for) induces fruitful sources of trouble when mismanaged.

Starting at the root of the question, it is first necessary to have a basis for prices that is beyond all dispute, and back of which there is no appeal. This is secured by a contract in duplicate, giving the molding price of each casting made, one copy of which is signed by the firm and one by the regular price committee appointed by the molder's union. Some of our members, who run non-union or open shops may object to this idea, but it certainly has been a most satisfactory way of meeting the question, and one that has worked without friction. When once signed, the lists stand as a basis for all time, and are religiously lived up to by both sides.

New work is priced before going into the shop, and in case of a dispute the firm has its signed list to fall back upon, which is an unassailable foundation. Of course wages are subject to a percentage increase or decrease

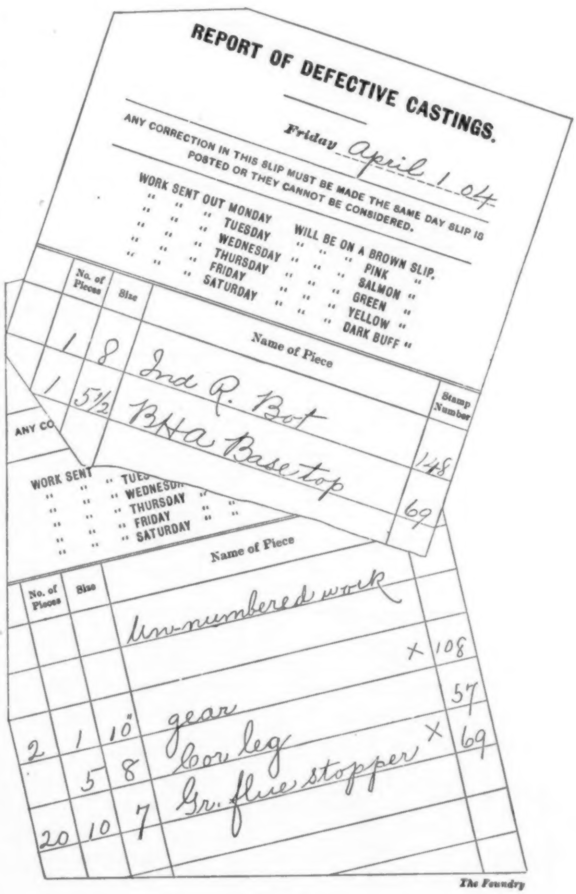


FIG. I.

in case of a general change throughout the trade at large, or any particular piece may be entirely re-priced in case the method of doing it, or the appliances used are changed at any time. But this list is always a basis on which he marks the cope of each mold. All castings pass through an inspector's hands for preliminary inspection, and he rejects the greater part of the defective pieces. But every man in the employ of the company is also held

MOULDING RECORD.

WEEK ENDING FRIDAY, April 8 190 4 NAME, John Smith NO. 148

NO. OF SHEETS TURNED IN 3

Size	Name of Piece		S	M	T	W	T	F	Total	Price	Total
8	Indiana Range Bottom	BAD							6	.12	5.04
		CASTINGS SENT OUT	9	6	9	9	7	8	42 / 48		
7	B+ End Shelf	BAD							1	.10	1.00
		CASTINGS SENT OUT	2	2	3	2	2		10 / 11		
	Ratchets	BAD								1/10	24
		CASTINGS SENT OUT	40	40	40	40	40	40	240		
10"	Gears	BAD								.20	20
		CASTINGS SENT OUT	1						1		
8"	Covers	BAD							9	2½	90
		CASTINGS SENT OUT	8	8	8	7	8	6	36 / 45		
7"	Covers	BAD							4	2	
		CASTINGS SENT OUT									
		BAD									
		CASTINGS SENT OUT									
		BAD									
		CASTINGS									
		BAD									
		CASTINGS SENT OUT									
		BAD									
		CASTINGS SENT OUT									

OFFICE CHECK

Price should be 3¢ .... LESS

.... MORE

TOTAL 7.38

PERCENTAGE INCREASE OR DEDUCTION 7.38

.08

7.30

KEEP THIS SHEET CLEAN

Fig. 3

The Foundry

the whole pace of the shop rests, and its value cannot be overestimated.

Each molder is assigned a number and given three stamps each bearing it, with which responsible for the castings that pass him, and many are thrown out by those who assemble the work.

The rejected castings are sent to the foun-

dry once each day, accompanied by a list made out as shown (Fig. 1). The number on the right being the molder's numbers as found on the castings. This dead heap, as it is known in the shop, is taken into the foundry at eleven o'clock each day and piled where it is easily accessible with the list posted near it. All work not bearing a number is posted on a separate sheet. Every workman has his chance to examine them, and should he find

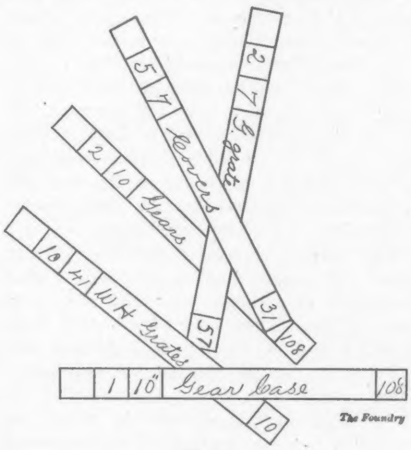


FIG. 2.

castings discounted to his number, the work is before him, and he can learn the cause. In case the piece has been debited to the wrong man through some error, or in case an employe considers a certain piece improperly discounted, he must bring the matter to the attention of the proper party before three o'clock, at which time the lists are taken down, the castings sent to the stage for remelting, and the transaction absolutely closed, no matter what mistakes or errors may have been made.

The sheet bearing the list of work with no numbers is also examined by each man, who may supply the missing number, writing it on the sheet himself, in case he finds one of his pieces included there.

When this list is taken down all unclaimed work is looked up, the number of the maker added, and the work discounted double as a penalty for not supplying the number (see pieces marked X, Fig. 1). After being turned into the office these lists are cut up, as shown in Fig. 2, to give the separate items, and filed in a rack composed of small pigeon holes, one for each man employed. An account of the work is kept by the workman himself on proper blanks (Fig. 3) and turned in at the end of each week, with the prices also filled in as shown. The firm takes a duplicate account, a clerk going through the foundry each night for the purpose. At the end of each week this is compared with the molder's record, the prices he has put down checked against the signed lists, the number of defective pieces as shown by the slips in the pigeon holes bearing his number are put on, these rejected pieces are subtracted from the total numbers made, and the balance is paid for.

Any castings that are sent into the shop at the time the list is posted may be taken from the pile, sent out, and since they have been charged and discounted once, the two transactions balancing, they are again charged by the molders as new work would be.

The pay sheets, after the totals have been transferred in the pay-roll, are returned to the molder, and before each payday each man is visited by a clerk who makes any corrections required in the spaces marked "more" and "less" on the record sheet. This clerk takes with him the signed lists and the discount slips arranged in a suitable rack, the lists being final as regard pay, the slips as regard discount.

Discount lists are written on different colors for each day in the week, so that it is possible to fix the exact date that each piece was discounted should the occasion arise for so doing. This is one of the best methods for handling the detail of this work, and seems to be very popular with the workman on account of its fairness to both sides.

THE CORE BENCH.

BY BENJ. D. FULLER, ALLEGHENY, PA.

The management of the core bench, while of the greatest importance in the production of good castings at a reasonable cost, does not always receive the consideration it should, hence a little discussion of the subject may be of interest.

Be the foundry large or small, it will pay to study the different sands and mixtures, selecting the most suitable for a given job or class of castings. For instance: We do not like to see a small, light-lettered, box casting come from the cleaning room shining, with letters perfect, no fins, showing good molding, but rough and lumpy in the inside from the use of an improper core, made of coarse sand and smeared over with thick blacking.

A good core for work of this kind will be found in one made of fine bench molder's sand and molasses water, used the same day or the day after making. It will give a casting as smooth and shiny inside as out. This core should not stand in stock where it will be subject to dampness or it will become soft and worthless, the molasses being amenable to moisture. No blacking should be used, and the burnt core is readily rapped from the casting. By adding a little new sand each day the material can be used repeatedly.

The mixture of ground rosin and fine sharp sand is an excellent one to use for certain lines of light and medium heavy castings, as it leaves them readily and gives a smooth finish. The rosin must be in proper proportion, as if too strong, the cores will be very hard and will blow. Even if they do not blow, the castings will be found to have a mottled appearance or be full of fine spots or holes. This core is quickly dried, and hence is the thing to use for hurried work where feasible. It cannot be handled hot, but must be allowed to cool in order that the rosin may become set. After this the core will be found quite strong. If equipped with a rosin pulverizing mill, this is an economical mixture.

Where a smooth, small hole is desired through a body of iron, molding sand and oil seems to be the thing, but where the core is light and of considerable length, a difficulty in using this mixture is that it will shrink and warp. While this can be overcome to some extent, it has its drawbacks in making cores of certain shapes. The oil and sharp sand core is an excellent one where strength is desired, also a core which will vent readily, and can be rapped from the casting easily. For cylinder jackets, ports, radiator and similar castings this is good.

The old saying that a thing "well begun is half done" is applicable particularly to core work, as where any considerable number of cores are to be made which present an uneven surface to be turned out upon the plate, it is wise to construct a pattern and cast dryers rather than to use a frame and bed in loose sand, as is practiced much.

Likewise in making large work much time and worry are saved by shaping an arbor pattern and casting a sufficient supply rather than hunting up rods of different sizes and shapes, bending and straightening, cussing and fussing over them, and frequently turning out a worthless core at that. Money is well spent in the purchase of good sifters, anvils and rod straightening and cutting devices, also in having a man straighten out and assort rods and hooks, arrange plates and attend to work of this character.

As is well known, sand that has been properly mixed and tempered is much more likely to produce good work than sand which has not been so treated. But as an illustration let me cite a case from experience: Cores for large work were being made from a mixture of compound and sand at a ratio of one part compound to twenty-two parts sand, mixed by hand. After installing a power machine which mixed and tempered the batch thoroughly, better results were obtained from a mixture of the same sand and compound at a ratio of one of compound to forty of sand. This seemed a reasonably cheap mixture, but by using different materials we are now able to produce sixty parts for the same cost as twenty-three parts first mentioned.

The foreman coremaker should be a man capable of at once deciding how and of what mixture a core should be made, who is to make it, etc. Time records should be kept. A record of boxes in and out of order is also essential, so that any desired box may be located quickly.

An accounting system whereby access can be had to the cost of general labor per pound of output as well as the cost of core material per pound will be found of value, as by this means comparisons can be made at any time.

As essentials let me also mention good ovens, cranes, handy water attachments, steam jets leading into bosh for mixing of materials, such as core compounds and blacking, etc. Over all vigilance eternal as well as rectitude of conduct in dealing with employes, and good results can be obtained.

A PLEA FOR THE COREMAKER.

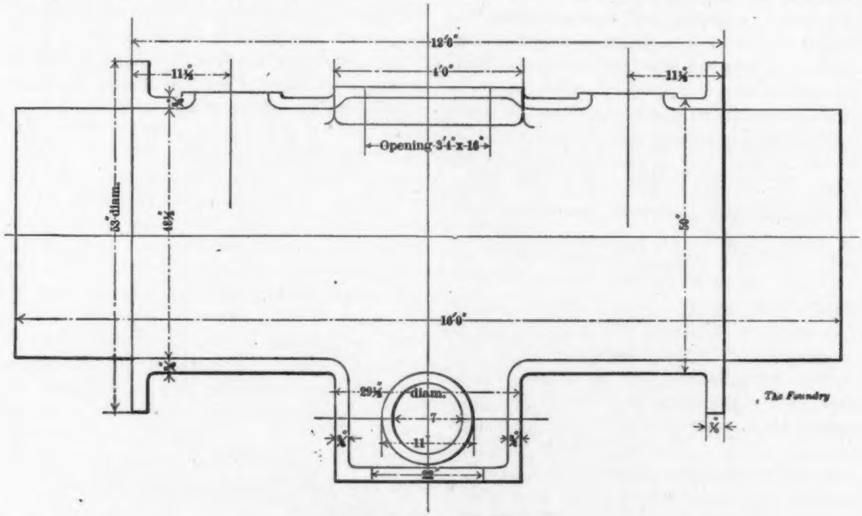
BY ALEX. T. NEIL, NEWARK, N. J.

While the technical press is full of articles on molding, I seldom see the art of coremaking commented upon to the extent that its importance warrants. I claim that coremaking is most certainly an art, and to its successful application does many an important foundry owe much of its prosperity.

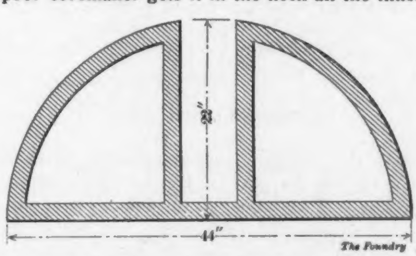
An experience in molding and coremaking for over thirty years allows me to say very frankly that the coremaker does not get the credit that is due him. He has to work in any old place, use any kind of sand that may be handy, his rigging is often most disreput-

able, his plates poor, and what lifting is to be done must be tackled by himself, and yet he is expected to turn out perfect cores.

Now why should the coremaker be treated any worse than the molder. If the latter has difficult work, he gets his helper, his facing, and has his iron brought him. The coremaker is blamed if the facing is not O. K., the mold scabs or runs, if the iron is too hot, it cuts, or if too cold, there is other trouble. If the core blows, it is also the coremaker's fault, if it is too big, it is his fault, if the iron gets into the vent, it is still his fault, and so the poor coremaker gets it in the neck all the time.



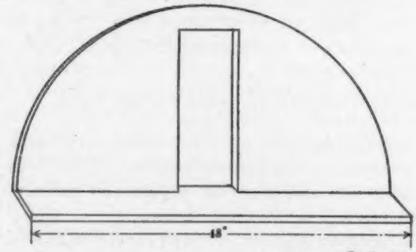
PATTERN FOR CONDENSER.



CLIPS WEDGED TO THE BAR EVERY 6 INCHES.

I had a very old foundry foreman tell me once that I had too many cinders in a 48-inch condenser core about 16 feet long. He held that the accumulation of gas was so great that it swelled in the mold, and robbed him of his metal. He evidently forgot that it was in the molder's hands to relieve the pressure and the real trouble lay in the brick wall built around the core at the ends to keep the iron in. This gave way, and very naturally some iron came out and found its way into the cinders which were acting as a barrier to the run out. This is simply cited as an example of the coremaker's troubles, and is not intended to screen either the careless molder or coremaker. Now if the foreman had put two binders across the ends of his flask and wedged his wall, there would not have been a word lost, and the condenser saved.

To explain this at a greater length—there was a large nozzle and flange situated on top



HALF OF END PIECE SAWED OUT FOR BAR TO PASS THROUGH.

of the casting, and in forcing the metal up, it was forgotten to secure the two weak spots, the ends. Incidentally the same foreman had me go over the cores with clay-wash while green, and blacking when they were dried.

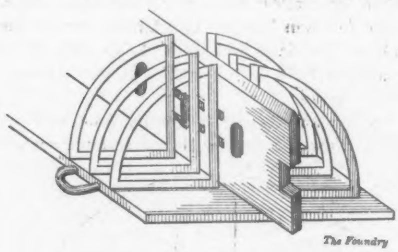
The result was that they came out dirty on top.

I claim that if you clay-wash a core while green, and then black it when it has been dried, you create a parting between the clay-wash and the blacking that will surely wash when the iron touches it. The proper way is to wash or sleek while your core is green, and it will stand the hot metal afterwards without trouble.

I have tried many core compounds, but none

BAR USED IN EACH HALF, HOLES TO CONNECT THE CINDERS.

of them will come up to expectations with the crude methods of mixing in use when it comes to pump cores. Where the sand is crushed and the compound mixed up with it in a thorough manner there will be no difficulty, and at least three of these compounds will beat flour easily, and do away with the blow-holes and scabs we hear about so much. If, therefore, the up-to-date foundry will get a sand crushed, and pay more attention to the core sand, the facings, and see that the sand is kept under roof summer and winter, then



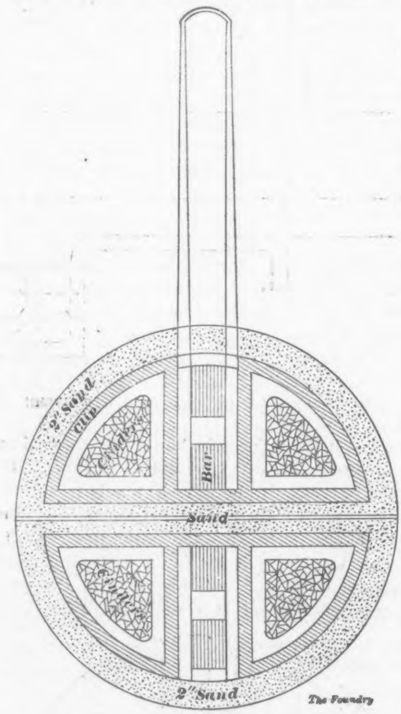
CLIPS AND BAR READY FOR THE SAND.

will the foreman get out results, the men be content, and the owners satisfied. Add to this good iron and both the molder and the core-maker will be positively happy.

Good rigging, clean floors, and the like allow the men to interest themselves in their work, and turn out more of it.

Now as to the criticisms about girl-core-makers. Why should this be more so in the foundry than in any other factory. We tried both boys and girls on small pump cores, with the result that the firm lost 75 per cent. on the small pumps where the boys were responsible, but since the girls were doing the coremaking this loss has been cut down to 10 per cent. Evidently the girl is a success in the core-room of the pump shop, and why not in other foundries. Girls are nimble and work faster than boys, and are easily taught.

Still another point must be touched upon. In case of trouble the foundry foreman will usually take the word of the molder if he complains about the cores, rather than investigate minutely. If he did this, he would not have to send for the patternmaker or coremaker to



SLING FOR LIFTING CORE.

right the trouble. Special attention to these matters on the part of the foundry foreman will save much money to the firm, as he is supposed to know better than any one else in the shop how the cores must fit, how they should be vented, etc.

Where cores are made by the piece work system, in shells or dryers, and baked in the Millet or other oven, it pays to keep track of the plates, which should be made as perfect as possible to begin with, and before they are put away, should be carefully oiled so as to be in good condition when wanted again. Plenty of oven room should be provided, or

there will be continuous trouble. There should be special ovens for taking cores which have been pasted, tied, and blacked, and gotten ready for the mold.

Right here is where much loss can be avoided. I think the system in use at the Worthington pump shops for their piecework cores made with stripping plates and dryers, as gotten up by Mr. James Smith, of that company, the most successful and economical I know of, especially as there are so many changes to contend with. For instance take a steam port job, where a journeyman made five right hand and five left hand steam ports, in the regular wooden boxes, for a day's work of 10 hours at $2.50. With the iron stool and stripping plate one girl can make 25 rights and 25 lefts for 2 cents each, size nine inches by six, by 10 inch stroke. That same girl could easily keep two other molding machines going on two smaller sized steam ports, one at 75 cents per 100, and the other at 53 cents per 100. And I could cite many more of such instances which have come under my personal observation.

I can only repeat, that give the girls a good clean room, have their work taken away and the baked material returned to them, give them a special dressing room, and make their surroundings such that it will be a pleasure for them to work in the core-room, and I can safely say that the results will surprise the most skeptical man in the foundry business.

I give herewith some sketches of the rigging used in making the condenser core referred to above. This should become the subject of some discussion, as there are no chaplets used in these condensers, and some of them are only seven-sixteenths thick. These castings used to be made in loam, but cost about 100 per cent. more than when made in dry sand.

Last, but not least, we have the foreman chipper to contend with. His men are all working by the piece, and to get this work done cheaply, he wants special core irons made, so that his men can clean up quicker. Where there is complicated work to be done, many are the woes of the coremaker, but I look forward, nevertheless, to the time when the work of the core-room will be better appreciated that it is at the present day.

SOME LABOR-SAVING SUGGESTIONS FOR THE FOUNDRY.

BY H. F. FROHMAN, CINCINNATI, O.

Many articles have been written on labor-saving devices, and important facts brought out, by able writers, but I desire to put the question before the foundrymen from the standpoint of the practical foundry supply-man, who has had many years' experience, and has visited probably almost all the leading foundries of this country.

I will not dwell on the necessity of having good equipment, such as suitable cranes, designed and constructed for the class of work they are to do, an up-to-date, economical melting cupola, with all the proper appurtenances; nor on a battery of exhaust tumbling mills for cleaning castings; nor on the methods for distributing iron; but will dwell on the minor articles, such as are usually overlooked in the large shop.

I readily appreciate the fact that many foundrymen will say we have all the foregoing, and why should we not produce our castings at the minimum cost? Yet there are many small labor-saving devices that can be introduced, which, used in connection with the more important equipment, and with good management should make the foundry business a successful one.

While foundry supply-men are considered a nuisance by some, to others, we are happy to say, they are heartily welcome. The foundry supply-man is brought in contact with the foreman and molders, and an exchange of ideas has resulted in many a simple and successful device being put on the market to the benefit of all concerned.

While the writer was visiting a certain foundry, he noticed a molder using a perforated piece of tin to hold up the core in the mold. The idea seemed to be excellent, and the explanation of the molder that the tin being perforated allowed the iron to alloy with it more thoroughly than would otherwise be the case seemed conclusive. The suggestion was taken up, and now perforated tin chaplets are on the market in all sizes that are required. Foundries making very thin castings have found them exceedingly serviceable; in fact, they would not do without them if they could help it.

Another simple thing is a core coating. This is used on a steel core, where a number of these may be used in one casting. The method is to dip the steel core into the coating, set it into the mold, and the iron will flow freely around it, making a perfect hole with neither a chill nor a blow.

A mold drying apparatus. This is a device for doing away with burning charcoal in a dry sand mold. It is used with a direct flame

from a torch, in connection with compressed air, the result being more economical and satisfactory than the old style.

My attention was also called to the chiseling out of follow-boards and match parts, and after much study and experiment with the assistance of the shop and the laboratory, a compound was gotten up which can be poured into a temporary mold, using the original pattern, and a satisfactory match made at one-tenth the cost of the old method. After setting, this match becomes almost as hard and as true as the iron itself, and makes an excellent follow-board or sand match, which becomes better as it gets older, and retains perfect parting.

In many foundries where dry sand molds are made, it seemed a hard problem to put a liquid blacking on the molds evenly and well distributed. It seems that when this blacking is prepared to use, and allowed to stand a few minutes the blacking settles at the bottom. This trouble is now obviated by using a compressed air blacking swab. This swab mixes and distributes the blacking very evenly over the surface of the mold, and can reach any part inaccessible to the hand. For this reason the result is much more perfect, and the castings brighter, cleaner and better in every way.

I might also mention the various designs of sand-sifters used in a foundry. By adopting these machines, many a dollar has been saved. There are now machines on the market which can riddle as much sand in one hour as formerly required the labor of two men for a whole day. It is also said that these machines temper the sand much more thoroughly Facing sand may be prepared by them, and their use in the core-room is also highly advantageous for mixing sand with the various compounds, flour, or rosin.

I remember, years ago, there was a certain foundry in Ohio, where they employed girls to make the cores. Should a stray salesman happen to wander in to see the foreman, these girls would spy him, and take all the conceit out of him that he ever possessed. I happened to be in that foundry again a few years later, dreading to approach that core-room, but to my agreeable surprise found the young ladies wanting, and instead two boys operating two machines for making cores which formerly were made by not less than twenty-five persons. The machines were constantly fed, and as fast as the wheel could turn made satisfactory cores, true and round, and well vented, in fact faster than the molders could use them.

In this same shop, powdered rosin was constantly used, and formerly two men were required to grind it by hand. Later on, a machine was devised for powdering and pulverizing rosin, which operated at a very low cost. It now runs for two hours, in charge of a boy, and produces more powdered rosin than is used for a day.

A word regarding the use of good facings and blacking may not be amiss. I have noticed that where formerly foundrymen used graphite by the pound, it is now used by the ton, showing conclusively that it is more economical to use high grade plumbago to face a mold, at a few cents cost, than to spend dollars in the cleaning room in cleaning and chipping castings. Furthermore, it is to the interest of the foundryman to purchase a grade of facings and blacking suitable to his respective class of work, and the very best is always the cheapest. As advancement has been made in the foundry, so it has in the manufacture of facings and blackings. The materials are turned out with the most modern machinery, and the raw materials kept under chemical control. The foundry-facing man now knows that he is furnishing the proper material for the particular purpose.

Many other simple labor-saving devices could be enumerated by me, as having come under my notice, and all of them would not only become sources of economy alone, but also result in considerable profit to the foundryman.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
Papers for the Convention at Indianapolis, June, 1904.

The Value of the Chemist and Metallurgist to a Manufacturing Plant.

BY H. C. LOUDENBECK, WILMERDING, PA.

The value of a chemical laboratory in connection with a manufacturing plant depends largely upon intelligent supervision and the proper application of results. A laboratory may be properly equipped with all the necessary apparatus, may contain the most sensitive balances, may have the most expensive appliances known to the art, and yet fail utterly for lack of intelligent supervision.

The percentage composition of a steel is of no value unless we know its meaning, and the proper use is made of the knowledge. The analytical chemist, after much labor, may report a complete analysis of a sample of insulating material, but unless some one can interpret these results and can use them intelligently, they are without value.

The proper use of a chemical laboratory may be accomplished in either of two ways: First, by employing a practical chemist, one who has had experience in a manufacturing plant and has been in actual touch with the shop, and can put his chemical determinations to some use, or in other words, make analyses that he can use. Second: By placing the laboratory under the direct supervision of one who can supervise and direct the work intelligently. No matter who has the direction, an outline of correct work toward beneficial results would be the same and would vary according to the kind of manufacturing carried on.

The education and training, as well as the practical experience of a man should be examined by the firm about to employ a chemist or metallurgist, for to be successful he must have both of these. It is desirable to have the college course followed by some experience in the laboratory where a variety of analytical work is performed, and to have the advice and counsel of experienced chemists, for accuracy and rapidity of the art can only be obtained in that way.

The experience necessary to successfully apply the laboratory results to a purpose is not easy to obtain, and is often gained at the expense of the employer. Here is a splendid opportunity for the technical schools to give the student some idea of how chemical and physical knowledge can be successfully applied to foundry practice. In this way the student will get practical advice from men who are experts and have learned from actual shop experience how to use theoretical training on the problems at hand.

The foundry is often part of a manufacturing plant, and when about to employ a metallurgist, his value to the plant as a whole should be considered. The tonnage from the plant may be too small, or the class of work too plain or unimportant to pay the extra expense of employing a chemist, but, when his value to other parts of the plant is considered, it may be that he is a paying proposition.

The following hints in regard to the practical application of the laboratory outside of the foundry proper may be beneficial. Chemical analysis as applied to iron and steel bought by a manufacturing concern. The tests should vary according to the use and grade of the steel. Often a soft open hearth steel is bought to be used in a forging machine where expensive dies are used. The percentage of carbon and phosphorus has a marked effect on the life of the dies and the quality of the forgings made. That is, the higher the percentage of these elements, the harder the steel and the greater the wear on the dies. It is threfore well to limit them and keep them as low as possible without materially increasing the cost of the steel. The cost factor should always be considered in a specification, but oftentimes an increased cost is justified by results.

A chemical specification, in fact any specification, should always be considered from the manufacturer's as well as the buyer's standpoint. A basic open hearth steel, on account of the low phosphorus, will often forge easier and the dies have greater life than acid open hearth or Bessemer having the same carbon content. For ordinary forgings, where expensive dies do not enter into the cost, Bessemer steel is suitable, limiting the phosphorus and sulphur to 0.10, and the carbon to 0.15.

The laboratory should be one of the means of testing the quality of a large portion of the material purchased, namely pig iron, coke, copper, spelter, lead, varnish, oils, fibre, rubber, tool steel, pigments, etc. It is not the actual analysis that are of value: They are a means

to a certain end. It is the advice to the purchasing agent and to the superintendent in regard to the purity and quality of the material that is of value.

The chemist should become familiar with the manufacturing process of not only his own plant, but also of the raw material his company buys. The question should not be so much, what is the analysis of the material, but can we use it. A man thoroughly understanding chemical technology and practical physics can make himself very valuable by giving advice in regard to material purchased. Many plants melting only 15 or 20 tons of metal per day could well afford to employ a practical chemist, knowing that he would be useful to the plant outside of the foundry proper.

The value of the metallurgist in the foundry may be due to two factors: First, improvement in quality, and second, reduction in cost. Making castings better, that is, free from porosity, stronger, easier to machine, will reduce loss and therefore reduce cost. A low cost in the mixture may mean an increased cost in the finished castings. It is largely a matter of good judgment, and the cost factor should be considered in all its phases. The object should be to use the cheapest mixture that will answer the purpose, and at the same time produce good results. This may be done by increasing the scrap, getting lower silicon irons, and using job lots, too risky for the ordinary foundryman.

The metallurgist should become familiar with the analysis of all the brands of pig iron in the market, and by proper selection, a saving of twenty-five to fifty cents a ton may often be made. If the iron is bought and placed in the yard without the laboratory as an aid, one of the greatest benefits of employing a chemist is lost.

Another factor may be mentioned. Iron in the yard should be used to the best advantage. A certain lot may be extra good, being low in sulphur and high in silicon and carbon. This should be mixed with scrap and gray forge in such a manner that the full benefit of the better grade will be realized. The ability of the metallurgist to make suitable mixtures is another valuable factor. A Western firm who make mining machinery had never been able to make stamp shoes that would give good service. The shoes were either too soft, or the necks would break. The metallurgist was given the problem, and he made 10 shoes which were used in competition with others of noted makers at the great Homestake mine in South Dakota. The result proved them to be the best of the lot, and now the firm receives an order for 5,000 yearly.

Two things are essential in controlling foundry mixtures: First, to know the correct composition, and second; uniformity. The latter is the most difficult to maintain. Ninety percent of the castings may be satisfactory, but the ten percent which are bad spoil the whole lot.

The utilization of the waste material may be considered the legitimate field for the practical chemist. Every manufacturing plant accumulates useless or unproductive material which is considered of no value. A man knowing the composition of this material and having a general knowledge of manufacturing processes may often suggest means of disposing this waste at a profit. This may be done by using it in some process or selling to some firm that can use it. Every engineer should be saturated with the idea of using, not saving, all materials not considered of value. Germany leads us in this respect. From coal tar we have acetanilid, phenol, and the beautiful dyes. From blast furnace cinder, cement and mineral wool. Blast furnace gas is being used in the gas engine. The bi-products are saved from coke-making, and alcohol is made from sawdust.

The importance of chemical technology in the development of our industries is not fully appreciated, and the greatest benefit from chemical knowledge obtained. The chemist should become more of an engineer, and the engineer should understand more of chemical principles. When our schools look to this, greater benefit will result.

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